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WATER CONSERVATION IN ONTARIO:

Implementing the User Pay System to Finance a Cleaner Environment

Technical Report

MAY 1991

MISA ADVISORY COMMITTEE

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REPORT HIGHLIGHTS

CURRENT ONTARIO WATER USE: WHY THE "STATUS QUO" ISN'T WORKING

- Ontario municipalities will double their per capita use of water and related energy by 2011 if current use patterns continue. This will create an economic crisis for Ontario water and wastewater utilities, and is potentially disastrous for Ontario's already degraded aquatic ecosystems.

- Already, pollution of the Province's water resources has reached a level that challenges the capability of our water supply utilities to meet current allowable toxic contaminant levels in their treated supply. The public are clamouring for lower risk levels to be set.

- 415 municipal wastewater treatment plants are discharging more than 90 tonnes of suspended solids and BOD every day to Ontario waterways. In addition, a myriad of toxic pollutants are contributed, primarily by the 11,000 industries using municipal sewer systems. Indeed, it is estimated that more than 70 kilograms of total heavy metals alone are discharged daily from these plants.

- The current pollution emanating from these municipal sources can be attributed in some degree to poor enforcement of existing control requirements over the past several years. More than 100 of the plants currently fail to meet regulatory requirements with 49 having failed for more than three years running.

- Ontario's water and sewage systems have an average age of about 50 years, and many contain components which are older than Confederation. Their current physical condition is deteriorating rapidly. Yet they represent an enormous investment, currently estimated at $50 billion in capital replacement. Annual spending on water and sewage system operation, restoration and expansion represents more than 1% of the Gross Provincial Domestic Product, making this one of Ontario's most significant industries.

- Values of this magnitude warrant improved management and operating procedures to assure that design capacities are adequate, that the systems operate to the maximum benefit of the public health and the environment, and that they are fail-safe and efficient in customer service.

- Urban storm runoff through combined sewer overflows contributes more conventional and toxic pollution (including heavy metals) to Ontario's receiving waters than several of the industrial sectors. In addition, their contribution of bacteria to receiving waters causes an acute threat to human health and impairs recreational water use.

- Similarly, in some urban areas, non-point source pollution from urban storm runoff contributes more lead, copper, cadmium and PCBs to the waterways than municipal and industrial sources combined.

- Canada uses more water per capita (360 litres per day for domestic use) than any other country except the U.S., but its municipal utilities sell water at a cheaper rate than utilities in any other country (30 cents per 1,000 litres). The crisis in Canadian water utilities and wastewater systems is created by two major defects:

    - **water is sold to customers and wastewater service provided at substantially less than cost.**

    - **this subsidy when combined with a lack of metering is resulting in wasteful use of water.**

This situation leads to:

- **overuse of our water resources, and coincidentally to its increased pollution.**

- **continuing deterioration of the physical integrity of our water and sewer infrastructure.**

- **non-productive government spending through subsidizing wasteful practices.**

- **need for oversizing water supply and pollution control works.**

  - **unfairness and irregularity in pricing of service among customer types.**

- The Ontario Government does not have a formal water conservation policy and, therefore, has no coherent framework to mandate or encourage water conservation. It does, however, have several mechanisms to establish water conservation at the municipal level through appropriate pricing and metering of the commodity.

CONCLUSIONS AND POSSIBLE SOLUTIONS

- We have reached a critical stage in attempting to manage appropriate municipal use of our water resources. Current management strategies are inadequate to cope with continuing wasteful practices. The environment is in a dangerous state of degradation. Current levels of pollution are already unacceptable, but are compounded annually through the continuing discharge of persistent toxics and heavy metals to receiving waters.

- Uncoordinated management and inadequate financing are blocking our ability to proceed with desperately needed solutions. Publicly acceptable methods must be found to change the status quo of this $50 billion industry and simultaneously provide:

  - **Finance required for municipal utility capital expenditures.**
  - **Effective management of municipal service costs.**
  - **Reduction of water consumption and use, and of waste generation.**
  - **Improvement of the effectiveness of water treatment and wastewater management systems.**
  - **Generation of revenues at or above costs to cover new capital and interest costs, and allowances for depreciation.**

- Provincial authorities should move now to adopt and implement a Municipal Water Conservation Plan for Ontario. The plan would be fully implemented over a 10 to 15 year period and would be similar to those currently in place in California and other American States. At the root of the plan should be the conservation of water and the requirement that the user pay the full cost of service. Full cost pricing of universally metered customers would:

    - **permit restoration of all systems before staggering replacement costs become a reality.**
    - **permit and provide for, on a budgeted basis, the desperately needed treatment improvements to protect our water resources.**
    - **reduce fiscal pressures on senior government budgets.**
    - **reduce water use and thereby reduce pollution.**
    - **ease demands on the physical capacity of water and sewage works.**
    - **permit fair and equitable pricing among customers.**

- The Plan should be developed over the next year by a Joint Program Committee comprising representatives of government ministries including Treasury and Economics, Municipal Affairs, Environment and Natural Resources, together with participants from municipalities, industry and public interest groups.

- The Plan should result in a requirement that each municipal supplier of water and wastewater service in this Province develop individually, or regionally with others, an Urban Water Resources Management Plan using the background and experience of the RAP process. This Urban Water Resources Management Plan would include provisions for metering, water recycling, wastewater reclamation, water fixture and appliance retrofits, pricing, rate selling and customer regulations. The recently enacted Water Conservation Plan of the City of Toronto embodies much of the intent of the recommended plan.

- The foregoing actions will require a capital outlay of $12 billion or more in constant dollars over the next 10 to 15 years. The revenues to pay for these programs must come directly from the water users. No longer will provincial subsidies disguise the real and growing need of the environmental protection industry: finance.

- Nevertheless, there will be a need for the Province to support, as the U.S. EPA and the American States have done, revolving loan funds and public/private partnerships to give some flexibility in financing and to assure municipalities of a source of borrowing at reasonable rates.

- Hardship cases will no doubt be revealed according to already established Municipal Board Guidelines and these can be dealt with through special borrowing arrangements.

THE IMPLICATIONS OF WATER CONSERVATION AND A "USER PAY" SYSTEM

- In the near future, repairs, replacement, and upgrading of Ontario's ageing water and sewer systems will require considerable increases in water and wastewater service charges to Ontario municipal customers. Today these rates supply only 65% of the monies spent on these services, the difference coming from provincial subsidies, property taxes and subdivision charges.

  This "hodge-podge" of arrangements is inconsistent with the concept of sustainable development which was stated by our National Task Force on Environment and the Economy in September 1987 as:

  > **Current practices should not diminish the possibility of maintaining or improving living standards in the future. This means that our economic systems should be managed to maintain or improve our resource and environmental base so that generations to follow will be able to live equally or better.**

- If we intend to meet our both our obligations under the Great Lakes Water Quality Agreement and our societal desire for a toxic free environment, we must charge users the full cost of water and wastewater services on a metered basis, as recommended by the Ontario Round Table, the Federal Water Policy, the Canadian Water and Wastewater Association.

- Since capital expenditures in excess of $12 billion will be required over the next 10 to 15 year period, charges for water and sewage services will probably have to increase on the average from about $70 per capita per year to about $250 per year, a compounding increase of 8% annually over that timeframe based on constant dollars. These increases equate to those anticipated in the United States where some households are already paying $800 per year as certain areas move to a "no discharge" concept.

- Charges of this order may still be less than 2% of household income and considerably less than energy charges now encountered by the average household.

- At full cost pricing levels, the percentage of total municipal expenditures directed to water and sewage services will rise from the current level of 8% to approximately 12%, but the source of funds will be entirely from revenue. This will have the effect of reducing pressure on the property tax base and eliminating the need for inadequate provincial subsidy. The consumer for the first time will be able to see the real cost of water and sewage services to the individual household and the consumer's personal contribution to restoring the water resources of the Province.

- A program of this enormity cannot be contemplated without a massive program of public involvement, because few issues evoke more public resentment and vitriolic comment than unexplained increased in taxes and utility charges. A well informed public and clearly defined structures to channel their participation in the full cost pricing of water and sewage services provide the only reasonable assurance that management decisions will take into account the full spectrum of public values. Such an approach not only contributes to more effective resource management but also motivates consumers to accept personal responsibility for the way they use their water resources.

- The RAP process has demonstrated that adaptability and flexibility in designing public participation programs of a regional nature were significant ingredients to success. On that basis, a wide range of approaches including stakeholder groups, advisory committees, public information meetings and the use of consultant specialists as facilitators is needed, together with a broad media awareness program and sound educational courses in schools.

RECOMMENDATIONS

1. Ontario must commit itself to the principle of water conservation to achieve several key goals:
   - to meet its obligations under the Great Lakes Water Quality Agreement, including the goal of virtual elimination
   - to rebuild crumbling infrastructures
   - to implement remedial actions in the Areas of Concern

2. MOE and the Ministry of Health should establish a Provincial Drinking Water Act and set maximum contaminant levels which are equivalent to internationally recognized acceptable levels of risk. Utilities should modify their treatment facilities accordingly.

3. **We must respond now to the philosophy and requirements of the Great Lake Water Quality Agreement by improving treatment levels and operation in municipal sewage treatment plants.** Full cost pricing will provide the funds necessary to:
   - Immediately implement and/or upgrade secondary treatment at all municipal sewage treatment plants (MSTP's) in the Province not providing equivalent treatment now, or inadequate in capacity to properly provide it.

- Protect the efficient operation of these plants by the introduction of municipal pretreatment programs to limit toxics discharged to these plants. (Demonstration programs will soon provide direction).

- Provide nitrification or nutrient removal facilities in instances where specific water quality objectives will be exceeded by secondary STP effluents.

- Introduce whole effluent toxicity testing (WET) of industrial and municipal effluents.

- Adequately treat the removed sludges to control the contained toxics including heavy metals.

- Improve the management and operation of wastewater control facilities to ensure a continuously acceptable effluent, through the training and certification of all levels of plant managers and operators.

4. The current MISA Program should be expanded to provide for the control and treatment of combined sewer overflows. This program should be integrated with current regulations under development for municipal sewer use and municipal sewage treatment plant effluent limits.

5. The Ministry of the Environment should initiate a province-wide analysis of the impacts of rural and urban stormwater overflows on Ontario waterways and devise a staged improvement program.

6. The current draft initiative of the Ministry of Natural Resources should be supported and expanded to institute water conservation practices as an Ontario Government initiative, including:

   - municipal water conservation plans using the experience of the RAP process

   - mandatory metering and full cost pricing of customers, and

   - introduction of the use of water conserving practices and fixtures.

7. The Ministry of the Environment should set minimum standards for adequate management and operation of water supply and wastewater control systems in Ontario.

8. The Ontario Plumbing Code should be revised immediately to require plumbing fixtures that conserve water.

9. A Provincial board or agency should be established to receive and hear applications from municipal utilities on rate revisions.

10. Ontario should develop and implement a province-wide Municipal Water Conservation Plan, to be implemented over a 10 to 15 year period, and to include provisions for water conservation and full-cost pricing of water and sewerage.

11. The Plan should be developed over the next year by a Joint Program Committee comprising representatives of government ministries including Treasury and Economics, Municipal Affairs, Environment and Natural Resources, together with participants from municipalities, industry and public interest groups.

12. In conjunction with the Plan, the Province should establish a major provincial water conservation information program for Ontario citizens.

13. In conjunction with the Plan, each municipal supplier of water and wastewater service in this Province should develop individually or regionally with others an Urban Water Resources Management Plan in response to the Ontario Municipal Water Conservation Plan, with provisions for metering, water recycling, wastewater reclamation, water fixture and appliance retrofits, pricing, rate selling and customer regulations. The Urban Water Resources Management Plan should contain the following ten elements:

    (1) An integration of current land use development, re-development and future development to provide guidance to the water management study.

    (2) An estimate of past, current and projected water use and wastewater generation responding to land use.

(3) An estimate of current urban runoff conditions and future impacts according to current and projected land use.

(4) Identification of the current conditions of water resources within the planning region and the various uses and impacts relating to differing land use and water consumer types.

(5) Water conservation measures currently practiced by municipal water and wastewater utilities, direct industrial users, and urban authorities to control water use, point and non-point water pollution discharges and ground water pollution.

(6) The needed water management programs required to meet the Provincial Water Conservation Plan and Provincial Water Quality Objectives.

(7) The relative environmental and economic impacts of these programs.

(8) A schedule for implementation.

(9) The public education and involvement program that was undertaken to develop and improve the plan prior to submitting the plan for provincial approval.

(10) A commitment to a regular 5-year review of the Plan.

WATER CONSERVATION IN ONTARIO MUNICIPALITIES

1. THE NEED

Recent environmental reports, including those of the World Commission on Environment and Development and the Canadian National Task Force on Environment and Economy, have placed emphasis on the global need for environmental conservation and sustainable development. These initiatives are critical if we are to halt environmental degradation and preserve our resources for future generations.

One of the most essential of our resources is fresh "drinkable, swimmable and fishable" water. Canada is abundantly supplied, with close to 9 percent (105,000 cubic metres per second) of the world's renewable water supply serving less than 1 percent of the world's population. Despite this apparent abundance, however, some areas experience shortages in water supply, while in others, particularly areas of urban and resource development, there has been considerable degradation of water quality.

Ontario residents have access to 10 percent of Canada's renewable water resources. The majority of these resources rise in the north and flow away from the major population centres to James Bay and the Winnipeg River. As a result, the 8 million people of the Province depend heavily on the Great Lakes Watershed (Canadian portion) and a share of the Ottawa River's flow, representing less than 5,000 cubic metres per second (less than 5%) of Canada's renewable flows.

Such concentrated use, combined with similar demands imposed by the 33 million Americans living in the United States' portions of the Great Lakes Watershed, has created untold damage to the quality of the subsurface and surface waters. This damage results not only from conventional pollutants such as biochemical oxygen demand[1] and phosphorus, but from a myriad of toxic and persistent toxic pollutants including pesticides and heavy metals.

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[1] Biochemical oxygen demand ("BOD" or "BOD 5") is defined as the amount of oxygen required by microorganisms to reduce the organic content in sewage to carbon dioxide, measured over a 5-day period.

The current U.S. - Canada Agreement on Great Lakes Water Quality (GLWQA) is dedicated to eliminating toxic and other pollution in these waters as well as to restoring the ecological balance of the system. Ontario's most ambitious response to this Agreement is the Municipal and Industrial Strategy for Abatement (MISA). This initiative is directed to implementing Best Available Technology Economically Achievable (BATEA) as a first stage in the treatment of all major direct industrial and municipal discharges into the Province's water resources. In later stages, MISA will impose increasingly effective treatment, towards its ultimate goal of virtual elimination of persistent toxic contaminants in the Great Lakes.

Although municipalities in Ontario represent only 6 percent of the total Provincial withdrawal of fresh water from the Great Lakes System, municipal discharges contribute a high proportion of total pollutant discharges. This is because, in addition to the 8 million people using the various municipal water supplies, there are 11,000 industries using municipal waters and discharging wastes into municipal sewers. For this reason, municipal controls under MISA are concerned with setting limits on industrial waste waters entering municipal systems, as well as on direct discharges from municipal waste water treatment plants.

Municipal concerns with water quality are diverse. They include a variety of potential or demonstrated use impairments, such as threatened drinking water supplies, reduced aesthetic and recreational opportunities, and polluted groundwater. The two major issues, a safe municipal water supply and an adequately treated and restored waste water discharge, are therefore of paramount concern to the people of Ontario.

Less emphasis is currently given to the impact of two so-called "diffuse" sources to receiving waters: untreated sewage from municipal combined sewer overflows, and contaminated urban storm runoff. Yet these sources are also major contributors to environmental degradation and municipalities must be prepared to make commitments for their ultimate control.

All of these sources of pollution can be reduced by the simple expedient of reducing water use, or water conservation. Water conservation has been defined as "activities designed to (1) reduce the demand for water, (2) improve the efficiency of use, (3) reduce losses, waste and pollution of water and (4) improve land management practices to conserve water" (1-1).

This study is directed at defining the primary role of Ontario municipalities in developing policies to attack pollution threats and to reduce water demand to reasonable levels. By 2011, municipal water use and related energy requirements could double over today's demands (1-2), causing major problems in the physical capacity and financing of municipal water and waste water utilities, while dealing a tragic blow to environmental restoration. In addition, global warming will reduce water availability through evaporation while increasing demands due to higher temperatures.

The immediacy and complexity of this urban issue is of major concern to the MISA Advisory Committee. Care must be taken to establish conservation programs which will be responsive and effective as well as complementary in all areas of water use. Other agencies and jurisdictions share this concern, and this report should therefore be considered complementary to initiatives such as the City of Toronto's recently-approved Water Conservation Programme, and the Ministry of Natural Resources' draft "Partnership Strategy for Encouraging Efficient and Sustainable Water Use in Ontario".

This report examines the current municipal water use situation with two primary objectives:

(1) to reveal the total conservation need in the urban use of water; and

(2) to enlist the public's understanding and support of that need.

2. CURRENT ISSUES

2.1 Introduction

In Ontario, we have too long ignored the value of our Great Lakes Basin water resources. Our urban population has had a major role in creating conditions that now threaten our health and livelihood. We have failed to manage watersheds in an integrated "ecosystem" fashion, instead juggling individual problems as they become critical. As a result, we have been wasteful in our water use and irresponsible in protecting and improving water quality overall.

The Great Lakes Water Quality Agreement of 1978, with its 1983 and 1987 amendments, committed the U.S. and Canada, including Ontario, to prohibit the discharge of persistent toxic substances and to eliminate pollution so as to restore the ecosystem. However, the International Joint Commission in its 1990 report found no evidence that either country or the related States or Provinces had made any formal commitment to comply with, let alone enforce, such conditions.

The continuing abuse of the surface and underground water resources of the basin threatens the health of its human population as well as the resident flora and fauna. This point is made clearly in a recent report on the state of the Great Lakes environment entitled "Great Lakes, Great Legacy" (2-1). High cancer and mutation rates have been found in at least 16 species of fish and wildlife in the Great Lakes watershed. As humans, we are a part of the "food chain" of organisms, and thus are ourselves potentially affected when we eat contaminated plant or animal tissue.

Since 1972, we have spent billions of dollars on the control of nutrient and conventional pollutants discharging to the lakes and their tributaries, yet appalling conditions of overuse and quality abuse still exist. Particular problems exist with toxic persistent chemicals. We are now on the brink of environmental disaster.

2.2 Sources and Types of Water Quality Impacts

Aquatic environments are increasingly threatened, both directly and indirectly, by municipal and industrial development. Direct impacts include chemical and oil spills, pesticide and fertilizer use, seepage of leachates from holding ponds, dump sites and landfills, industrial and municipal waste water effluents, and urban and rural storm runoff. Water quality is also indirectly affected by shoreline development, dams, channelization of streams, encroachments (structures such as docks and wharves that impede natural current patterns), pipe crossings, and the erosion they create.

The Water Quality Branch of the Inland Waters Directorate of Environment Canada estimates that human impacts on the environment are increasing daily, with more than 4 million chemicals currently registered and 32,000 in present use. The International Joint Commission believes that this number is rising by 10% a year and that at least 800 of the 32,000 chemicals now in use are toxic to humans or other animals or both. Many also persist in the environment and can accumulate in the tissues of plants and animals.

"Conventional" Pollutants

Biochemical oxygen demand ("BOD" or "BOD 5") is defined as the amount of oxygen required by microorganisms to reduce the organic content in sewage to carbon dioxide, measured over a 5-day period. High concentrations indicate high levels of organic content remaining in the flow, implying that effective treatment was not provided. High BOD levels can cause depletion of oxygen in receiving waters and associated effects such as fish kills, and taste and odour problems.

Elevated levels of **suspended solids** discharged to lakes and rivers also can cause serious degradation. Some of these effects are physical. In addition to obvious deterioration of aesthetic quality, fish and other aquatic organisms may die due to clogging of their respiratory passages. Important fish spawning and "nursery" areas may also be blanketed by silt, changing their physical characteristics and rendering them unusable. Suspended sediments also pose a chemical hazard to the environment, however. Many pollutants, including phosphorus, heavy metals, and trace organic compounds, have a strong affinity for sediment, tending to bind to particle surfaces. Contaminated sediments therefore become a reservoir of toxins, which may be re-released to the water column under certain conditions.

The **phosphorus and nitrogen** content of the receiving waters is also important. These compounds occur in nature, and are essential **nutrients** for plant growth. Elevated levels, however, can significantly increase the growth of algae and aquatic weeds, creating taste and odour problems, aesthetic damage to recreational areas, and reduction of fishing, swimming, and boating potential. As those plants die, and their tissues decay through the mediation of oxygen-using microorganisms. Where there is excessive plant growth, there may also be excessive decay and consequently serious depletion of dissolved oxygen in the water. Reduced levels of dissolved oxygen create an environment that is inhospitable for fish and many other animals, thus changing the species composition of the contaminated area.

A major use of Great Lakes water is for cooling spent steam in the production of electricity. **Waste heat discharges** raise water temperatures in nearshore waters, resulting in changes in the types and numbers of organisms present and increases in local decay rates in low flow periods. Increased decay rates in turn can create taste and odour problems in nearby water supplies.

Radioactive Substances

Nuclear materials such as radioactive isotopes (e.g. uranium, tritium) can also be highly toxic and persistent contaminants in receiving waters. For example, even the smallest dosage of uranium and its byproducts, released through mining, processing and utilization activities, may cause damage to exposed organisms. More serious genetic effects may result from long term exposure to radiation.

Trace Organic and Inorganic Compounds

Chemicals that are not easily eliminated from body tissue are referred to as "persistent". They have the potential to accumulate in plants and animals, and thus to "biomagnify" up the food chain. Not all persistent chemicals are equally toxic, but those that are both persistent and highly toxic pose a particular threat to the food chain, and thus to the stability of an ecosystem.

Toxic substances have been defined by the Inquiry on Federal Water Policy (2-2) as "those chemical substances which when released to the environment or if thereafter chemically transferred through combination or otherwise, could pose a threat to natural ecosystems or to the human health or well being."

Toxicity can refer to acute effects, where exposure to the chemical rapidly results in death or severe impairment of function. **Acute toxicity** can occur through a high dose of a moderately toxic contaminant, or a low dose of a highly toxic contaminant. By contrast, **chronic toxicity** is usually much less dramatic, often manifesting itself in damage to genetic material (mutations) or reproductive failure. Chronic toxicity typically occurs through long-term, low level exposure to contaminants. It is interesting to note that acute and chronic toxicity symptoms for the same contaminant may be very different. For example, acute mercury poisoning rapidly leads to convulsions, nervous system failure, and death in humans. By contrast, chronic mercury poisoning is characterized by perceptual changes, tremour, and other subtle symptoms easily misinterpreted as trivial.

It is difficult to assess the overall risks inherent in toxic chemical exposure, because most of the available scientific research involves studies of laboratory animals. Impacts on humans are estimated from the results of these animal studies, but since no two organisms metabolize chemicals in the same way the risk estimates cannot be conclusive.

Even more difficult is the weighing of benefits of chemical use against those risks. Virtually every chemical currently in use has some strong benefit; for some, those benefits may be so great as to outweigh the risks of use.

Pesticides, for example, are used to improve the productivity of agriculture and forestry by as much as 300%. Nowadays, pesticides are usually synthetic organic (carbon-containing) chemicals, although in the last century many inorganic pesticides, such as arsenic- and sulfur-based compounds, were also popular. While they provide enormous benefits, including control of insect-borne diseases such as malaria that affect millions of people, modern organic pesticdes tend to accumulate in animal fatty tissues. Thus, intentionally-released pesticides can also have dramatic effects on other, non-target organisms in rivers and lakes. A classic example of this is the accumulation of the pesticides DDT and Dieldrin in the tissues of Great Lakes birds such as the herring gull. Reproductive impacts, such as eggshell thinning and related poor hatching success, can be directly attributed to the contaminant burden borne by these birds.

A more complex problem is the daily use of thousands of **synthetic industrial organic chemicals** as raw materials, products and additives. **Inorganic chemicals, such as heavy metals,** also play an important role in industrial processing. Trace elements and heavy metals such as arsenic, boron, cadmium, chromium, lead, copper, zinc, and mercury are known to be present in water in forms that are easily taken up and accumulated by plants and animals. Many of these contaminants, although not so designed, are toxic or become so through process change. To make matters worse, the spectrum of available chemicals changes constantly, as new compounds are developed for new applications. It is a gargantuan task to identify each of these and assemble information on its persistence and toxicity.

In summary, chemicals vary widely in their effects as they accumulate and pass through the food chain. The terms "persistent" and "toxic" must be considered to be relative, because the effects of any chemical or mixture of chemicals depends not only on its basic properties and composition but also on the dosage, route and time of exposure, condition and susceptibility of the organism exposed, and other factors.

2.3 Drinking Water Impairment

When our original water supply systems were built 25 years ago, they were designed to cope primarily with bacterial contamination and decaying organic matter from municipal and industrial waste water. Today, those systems must deal with a far more complex mixture of contaminants than they were designed to handle.

Among the potential sources of drinking water contamination are:

- Diffuse air borne contaminants, such as sulphuric acid, that create corrosive conditions in our water supply and distribution systems and promote the release of metals into drinking water

- Agricultural, rural and urban runoff, containing sediments lost through erosion, with their associated pesticides, fertilizers, and heavy metals from atmospheric sources and roadway deposits

- Trace organic compounds from treated municipal and industrial waste waters where the treatment plants were designed to remove "conventional" pollutants like suspended solids and biochemical oxygen demand

- Direct spills and seepage of leachate from existing or abandoned landfills

Drinking water in Canada is governed by the Guidelines for Canadian Drinking Water Quality (1978), which have no force in law and are thus not legally binding. They were developed by a Joint Committee on Public Health Engineering of the Provinces with Canada National Health and Welfare in 1968. In 1986, they were revised and extended by a Federal-Provincial Working Group on Drinking Water under the aegis of the Conference of Deputy Ministers of Health.

The guidelines are used as a yardstick to assess the suitability of water for drinking purposes within the Federal domain and have been adopted by several Provinces as their own objectives. Ontario has issued its own drinking water objectives based largely on the guidelines but incorporating changes in certain parameters to reflect local considerations.

Under the Federal-Provincial Guidelines, the maximum acceptable concentration (MAC) is defined as the maximum allowable concentration of contaminants not producing visible health effects or objectionable aesthetic properties (taste, odour, appearance). Although the MAC is defined as a "safe" level of exposure, the Canadian guidelines do acknowledge that much more stringent criteria are generally desirable to ensure the highest possible water quality; this level is known as the objective concentration (OC).

The Canadian Drinking Water Guidelines are significantly more extensive than in many other countries. The Canadian MAC is generally similar to its U.S. equivalent, called the maximum concentration limit or MCL, for most chemicals. This is not surprising considering that both sets of guidelines are based on similar or identical scientific data and criteria. However, in the case of trihalomethanes (THMs), the Canadian MAC is much more lenient (350 mg/L) than the U.S. standard (100 mg/L) because of differing scientific rationales governing the estimation of risk for carcinogenic (cancer-causing) hazards. (It should also be noted that, in the U.S., legally-enforceably drinking water standards have been set under the federal Safe Drinking Water Act of 1974. There is no Canadian or Ontario equivalent legislation to govern drinking water quality.)

As discussed in Section 2.1 above, most risk assessments rely on evidence of health effects in occupational settings or on data compiled from experimental animals. One of the greatest obstacles to assessing risk for drinking water is our current inability to obtain reliable and unambiguous evidence of the health effects arising from exposure to trace amounts of toxicants.

Ontario municipal water supply systems, according to the statistics of the World Health Organization, have virtually eliminated sickness from bacterial and viral sources so that they are as safe as any in the world. However, our success in controlling microbial pathogens in municipal water supplies is today overshadowed by the threat of trace quantities of synthetic organic compounds and heavy metal pollutants. Furthermore, we have no way of knowing how long our drinking water has been contaminated with these materials. Only in recent years have laboratory analytical technique become sufficientLy advanced to allow detection of trace chemicals at all.

Although these contaminants are in very low concentrations in most drinking waters, we cannot be confident that the risks of lifetime exposure to them are negligible or non-existent. We are in fact operating a large scale human experiment and we are gambling that no ill effects will occur. There is genuine concern that, at least in some areas, increased water treatment of a more sophisticated nature may be required to maintain particular contaminants at zero or safer levels.

In Ontario, there are 553 separate distribution systems receiving water from 467 supplies as follows (some water supplies, such as Metropolitan Toronto, serve more than one distribution system):

Region	**Municipal Systems**	**Ministry Operated**	**Surface**	**Groundwater**
South Western	140	55	32	62
West Central	65	7	18	37
Central	150	13	40	96
South East	95	23	44	37
North East	76	24	40	34
North West	27	12	22	5
Totals	553	134	196	271

Most of the surface supplies undergo chemical and physical treatment (designed to clarify and filter the water) in addition to chlorination, while most groundwater systems have chlorination only. A few undergo additional treatment.

The Ontario Ministry of the Environment maintains a Drinking Water Surveillance Program (DWSP) which in 1988 reported on the quality of 50 municipal supplies. The results showed that only two systems (Alvinston and Dresden) failed to meet Ontario Drinking Water Objectives, showing total nitrates at elevated levels while all other health related guidelines were met. Currently, more than 70 systems are sampled and tested under the DWSP, with approximately 10 to 15 systems added to the program each year.

The public, however, remains concerned that the presence of many toxics in municipal supplies, despite their levels being below drinking water objectives (where available), represents undue risk. In consequence, many people are choosing to drink bottled water, and/or water treated with a point-of-use treatment system, on the assumption that such action will reduce health risk.

Unfortunately, both alternatives may increase risk of bacteriological contamination and despite their high cost (up to $500 a year) may provide no assurance of improved health protection. In a recent report on drinking water sources for the City of Toronto, the City of Toronto Department of Public Health noted that virtually all chemicals present in Toronto tapwater are at levels below a one-in-a-million increased risk of cancer or, for non-carcinogens, at levels below which any observable health effects would occur over a lifetime of ingestion. By contrast, bottled water was found to be of highly variable quality with respect to chemical and bacteriological contaminants. New, well-maintained point-of-use devices had the potential to remove many chemical contaminants present in tapwater, but showed frequent and serious violations of bacterial guidelines (2-3).

2.4 Point Source Pollution

Municipal Sources

During 1988, 415 municipal sewage treatment plants (STPs)[2] were operated in Ontario and were required, under Ministry guidelines or their Certificates of Approval (C of A), to reduce the 5-day biochemical oxygen demand (BOD), the total suspended solids (TSS) and total phosphorus (TP) of their influent flows to levels that approximated:

	BOD Removal	TSS Removal	TP Removal
Primary Treatment Plants	50 %	70%	1 mg/L or less
Secondary Treatment Plants	25 mg/L	25 mg/L	1 mg/L or less
Lagoons - batch	25 mg/L	25 mg/L	1 mg/L or less
- continuous	30 mg/L	40 mg/L	1 mg/L or less

The foregoing are set as annual averages, except total phosphorus which is measured on a monthly average. These parameters are used to measure the quality of influent and effluent and therefore serve as indicators of plant performance (2-4).

In 1988 the above plants treated a sewage flow from approximately 7.2 million people and about 11,000 industries discharging effluents to the municipal sewer systems. Some plants received more than 40 percent of their total annual flow from industrial sources.

The total combined flows treated by these plants represent an annual daily average of 4,974 x 1000 m^3, with individual plant discharges ranging from 764.7 x 1000 m^3 at the Metropolitan Toronto Main Sewage Treatment Plant to zero flow at lagoons not discharging in 1988.

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[2] Some industries and other facilities have private, on-site wastewater treatment plants. It is therefore important to distinguish between municipal plants, serving the public and indirect industrial dischargers, and privately-owned STPs. For the purposes of this discussion, it will be assumed that "STPs" refers only to municipal plants.

Twenty-nine of the plants provided only primary-type treatment[3], 157 represented lagoons of various types, while 216 represented plants providing biological treatment of some type (usually activated sludge)[4]. (Lagoons provide biological treatment but at a decreased and variable intensity. They are therefore regulated so that their discharges occur only when the intensity of treatment is at a maximum.)

During 1988, these plants discharged an estimated total of 92 metric tonnes of BOD, 98 tonnes of TSS and 4.75 tonnes of TP during the average day. In comparison, the seven petroleum refineries in the Province discharged less than one metric tonne of TSS and 0.005 tonnes of TP in an average day. Fifty-three of the 415 STPs were not assessed against Ministry performance guidelines because of insufficient data.

Two hundred and fifty-three of the 362 plants that were assessed met all effluent criteria while 109 or 30% failed to do so. Of the failing plants, 49 had not met Ministry guidelines three years in a row even though 22 of them were Ministry operated plants.

This situation is unacceptable. To continue to permit municipal STPs to fail to meet Provincial requirements, and to allow some of them do so year after year, shows a clear lack of responsible enforcement.

To date, Certificates of Approval and effluent guidelines for STPs have not required the control of toxic and persistent toxics including metals. Typically, STPs in Ontario are not designed, built or operated for the removal of these pollutants. Yet as industrial use of municipal systems increases, an increasing load of toxic organic and inorganic pollutants is entering--and in some cases, passing through--municipal STPs.

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[3] "Primary" treatment means that waste waters have been allowed to settle in a tank or pond. While water treated in this way is clearer than untreated waste water, it may still contain high levels of phosphorus, nitrogen, and other chemicals. Primary treatment usually includes chlorination to disinfect waste waters of bacteria and viruses.

[4] "Biological treatment" means that, after primary treatment, the waste water has been transferred to a second tank or pond in which a population of certain bacteria is cultivated (hence "biological" treatment). These bacteria break down organic wastes (BOD) and nitrogen compounds to forms that are less toxic in receiving waters. "Activated sludge" is one type of biological treatment.

The continuous variability of an STP's influent, the interactions between chemicals, the sensitivity of biological sludges to toxic pollutants, and even the quality of the municipal raw water supply all make it difficult for present secondary plants to reduce toxic pollutants consistently.

A pilot study of 37 STPs (2-5) conducted for the Ministry of the Environment in 1987-88 revealed that, on average, 80 to 85% of 144 toxic materials present in the raw sewage flows were removed by secondary treatment plants. The MISA Advisory Committee (2-6) analyzed these data as they applied to metals and found that mean metal removal efficiencies ranged from 70 to 80% with the exception of nickel (29%) for secondary plants; between 70 to 95% for lagoons; and between 30% to 70% for primary treatment plants. EPA estimated in 1986 that biological treatment systems fully acclimated to toxic substances were capable of 92% removal of these contaminants.

However, Ontario's experience indicates that the more normal removal of 75% on average will leave 170 kilograms of metals per day discharging to the Province's waterways. The petroleum industry's total discharge of 13 kilograms of metals per day to our provincial waterways seems trivial in comparison.

By far the most important source of trace contaminants in STPs is indirect industrial dischargers. One obvious solution to the problem is therefore to require pretreatment of industrial effluents before they enter municipal sewers. Indeed, such action may be critical in assuring the virtual elimination of toxic discharges from STP effluents.

2.5 Sewer and Supply System Conditions

For more than 15 years, technical journals and the public media have raised the spectre of a crumbling infrastructure and the high cost of replacing aging public facilities if they are not soon rehabilitated. Often, spectacular examples of collapsed bridges gain the greatest attention even though municipal water and sewage works, far more numerous, show through main bursts and sewer collapses that they too are entering old age. In fact, many of these systems have components built before Confederation, with the average age of water systems in Ontario reaching 50 years and the age of sewer systems probably lagging by 10 years.

Comprehensive technical assessments of the need for water and sewage works rehabilitation have been few. Some of the best, especially for underground pipes and services, are the detailed analyses carried out in the United Kingdom during the 1970s. Here a national committee formally addressed the issue and provided factual data (2-7). Their studies gave rise to a major rehabilitation undertaking, now nearing completion.

Unlike the United Kingdom, neither Canada nor the United States have undertaken a detailed inventory of the condition of their municipal water supply and pollution control systems. Instead, several recent (1980s) "needs assessments" have identified infrastructure investment needs, assessed the amounts and sources of financing available under current policies, and calculated the gap between the two.

Probably the most significant study of this type in the United States was the Report of the National Council on Public Works Improvement tabled before Congress in 1988 (2-8). In Canada, the Federation of Canadian Municipalities authorized a survey of Canada's urban infrastructure (2-9) that was released in 1984. That report was followed by further reference to the condition of the water and sewage systems of Canadian municipalities in a report of the Inquiry on Federal Water Policy of September 1985 (2-2).

Studies specific to Ontario were undertaken in 1983, 1986 and 1987 (2-10, 2-11, 2-12), all of which assessed the needs of water and sewer infrastructure in the Province. Although there are contradictions in the findings of these various studies, there is fundamental agreement among them regarding the magnitude of the problem, as follows:

1. There is a genuine need in many systems to establish an adequate inventory of water distribution and sewerage and to determine their physical states.

2. Present water and sewer systems with adequate rehabilitation programs should be capable of a structural life of 100 years or more, and perhaps even an infinite life.

3. Many major urban water and sewage works systems have reasonable rehabilitation schemes in place. Smaller systems (serving fewer than 10,000 persons) therefore present the most serious problem and have the major impact on provincial, state and national rehabilitation cost estimates.

4. All studies indicated the need for municipalities to set utility rates at a level to permit the system to be financially self-sufficient. Most municipalities currently set water and sewerage rate well below their actual costs.

5. Most studies confirmed the need for senior government capital assistance to initiate a "catch-up" program over the short term, and to set the wheels in motion for setting the price of water supply and waste water treatment at levels equal to their cost.

In response to these findings, the Ontario Ministry of the Environment initiated a "Lifelines" Program (2-13) on June 24th, 1987. Lifelines offers financial assistance to municipalities so that they can repair deteriorating municipal water and sewer pipes and services. Depending on a municipality's needs, these grants will cover no less than one-third of the rehabilitation costs involved and no less than half the cost of a needs study.

Despite the fact that many major water and sewer utilities have had rehabilitation programs in place for some time (the City of Toronto since 1967), municipalities have not leapt at the opportunity presented by the Lifelines program. As of March 31st, 1990, two hundred and six needs planning studies had been funded (approximately 25% of those required), but associated capital spending on rehabilitation appeared to be much less than required. Although $18 million was made available by the Province in 1988-89, only $12 million of it was used by the municipalities. This indicates (because of the cost sharing arrangement) that utility rehabilitation capital spending was less than $40 million in 1988-89. Such a spending level is only 25 to 33% of the total required to maintain the life of the more than 37,000 kilometres of watermains and 30,000 kilometres of combined or sanitary sewers (excluding watermain services and sewer connections) that exist in the Province.

If rehabilitation is delayed any longer, complete replacement of these aging systems will become necessary, requiring capital investments of twice the value of some rehabilitation programs. Broad estimates of the current replacement value of municipal water supply systems including intakes, pumping stations, treatment facilities, storage tanks, reservoirs, distribution systems and services for water have been placed at $30 billion, or about $3,750 per capita served(2-10, 2-12).

Similarly, the replacement value of municipal wastewater control systems in the Province (including sewers, private connections, pumping stations, forcemains, sewage treatment works and outfalls) has been estimated at $20 billion, or about $3,040 per capita served (2-10, 2-12).

Values of this magnitude warrant significant management programs to ensure that:

- actual water demands and sewage flow rates do not exceed design capacities of plants, pumping stations, watermains and sewers;
- all systems are adequately maintained to function as intended in their protection of public health and the environment;
- systems are reasonably protected from interruption of service to customers, through spills or outright failure;
- management and operating personnel are adequately trained and suited for the job responsibilities to ensure continuity and adequacy of service; and
- funding for rehabilitation, preventive maintenance, major maintenance, and the provision of supplies and services is available in sufficient amounts.

Previous sections of this report have suggested that one or more of these programs are inadequate and that systems are currently performing at less than intended levels.

It is inconceivable that investments of this order should be permitted to be jeopardized by inadequacies in capacity, maintenance or operation.

2.6 Combined Sewer Overflows and Urban Storm Runoff

"Non-point" pollution from urban runoff is a diffuse but major source of contamination from conventional pollutants, nutrients, toxic chemicals, metals, and sediment. All represent a major problem in receiving water quality, as well as a monstrous challenge in control management and finance.

Combined Sewer Overflows

The most obvious pollution source is **Combined Sewer Overflows (CSOs).** In the nineteenth and early twentieth centuries, combined sewers were accepted as a logical solution to water pollution control problems in urban centres. During dry weather, properly functioning combined sewers carried all sanitary flow to the waste water treatment plant. However, during storms or even winter thaws, stormwaters joined sanitary sewage and the combined flows often exceeded sewer system and treatment plant capacities. To avoid basement flooding and exceedence of treatment plant capacity, the excess flow was discharged directly to the receiving waters at one or more points of overflow. In Ontario, more than 100 municipal sewerage systems still contain significant sections of combined sewers, despite the fact that no new sewers of this type have been permitted to be installed in Ontario during the past 50 years. Indeed, most combined sewers were constructed before 1900.

As a result of industrialization and population growth within the older communities served by these systems, CSO discharges during periods of rainfall and thaw are now a major threat to water quality and other water uses. A CSO event can result in significant discharges of organic materials, nutrients, bacteria, oil and grease, metals, and other potentially toxic substances to receiving waters.

Indeed, the U.S. EPA's data and analyses established that, in addition to discharges to municipal STPs, industrial users of municipal sewers discharge approximately 500,000 tonnes of toxins, via combined sewers and CSOs, directly into U.S. receiving waters annually (2-14). This figure exceeds the total volume of toxins discharged to STPs by eight significant industrial categories currently regulated under EPA's pretreatment program.

There is no question that, despite the dilute concentrations of toxins including metals in CSOs, the total volume of waste water they carry makes them a source of considerable concern[5]. Because they carry sanitary flows, CSOs are characterized by extremely high bacterial concentrations, and thus pose a devastating threat to the safety of receiving waters insofar as public health is concerned.

The high cost of replacing or improving combined sewer systems has complicated efforts to arrive at a suitable corrective procedure. Over a period of 25 years, some cities (such as Toronto) have followed a program of sewer separation based on constructing road sewers to relieve existing combined sewers of road drainage and the runoff from new construction. Others (such as Chicago) have practiced off-line storage to contain the runoff event, later returning the stored flows to the sewer system for treatment after the event. Some cities have employed in-line storage with real time control, using the full capacity of the sewerage system before discharge (for example, Minneapolis); others (such as Detroit) employ direct treatment of the overflows at the treatment plant or the overflow site, using sedimentation with or without chemical treatment. Finally, some cities employ end-of-pipe treatment with "Swirl Concentrators" (Washington, D.C.) (2-15).

The control of CSOs in the United States has now been embodied in the requirements of the National Pollution Discharge Elimination System (NPDES) permit for a publicly owned treatment works (POTW or municipal STP), therefore recognizing CSOs legally as point discharges. The American experience indicates that the development of CSO improvement strategies and controls is an essential ingredient in water quality management.

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[5] This is an important point indeed. The concentration of a chemical (usually expressed in units such as "milligrams per liter") may be low, but if enough is discharged over a period of time it can still be an important source. For this reason, it is often useful to know the total quantity, or "load", of pollutant discharged. Loads are calculated by multiplying the concentration of a pollutant times the rate at which the effluent is being discharged (e.g., milligrams per litre times litres per day). Loads are usually expressed in units of mass per unit time, such as milligrams per day or kilograms per year.

Urban Storm Runoff

The second aspect of non-point pollution from urban runoff is **storm water overflows.** In spite of recent improvements in the control of point source pollution, water quality goals and beneficial water uses are unattainable in most receiving waters without some control of storm runoff.

"Runoff" refers to rainwater that runs off rural or urban lands, taking with it a variety of pollutants. Eroded or washed-off sediment is often a large component of stormwater runoff, but many other pollutants are also of concern, including trace organic and inorganic pollutants (especially heavy metals) that are bound to particles, and bacteria from animal feces.

The impacts of storm runoff can be classified as acute or cumulative. Acute effects are typically short-term problems that result from a single rainfall event measured in hours. Examples of acute effects include turbidity in a small creek and the bacteriological contamination of recreational areas after a summer storm.

Cumulative effects are typified by a gradual build-up of pollutant concentrations in receiving waters and bottom sediments. Work carried out at the National Water Research Institute (2-16) revealed that stormwater is a major contributor of several key pollutants, relative to municipal and industrial point sources (see Exhibit 1). These results confirm the need to improve controls on urban storm water runoff.

The International Reference Group on Great Lakes Pollution from Land Use Activities (PLUARG), established by the International Joint Commission, found in its report of 1978 that surface runoff into the Great Lakes created pollution by transporting phosphorus, sediments, industrial toxic chemicals, pesticides, fertilizers and some heavy metals (Exhibit 2). The report used phosphorus as a means of demonstrating loadings to the Great Lakes from a variety of sources including land use runoff (Exhibit 3) (2-17), concluding that thirty to fifty percent of the phosphorus loads to the Lakes come from diffuse sources.

PLUARG strongly recommended management plans stressing site specific approaches to reduce the nutrient, sediment and toxic loadings derived from urban areas. Post-PLUARG developments, reported by the IJC in August 1983 (2-18), indicated that cost effective management practices and implementation programs are generally available and have been demonstrated within the Great Lakes Watershed. Nevertheless, the Non-

EXHIBIT 1

Pollutant Concentrations in Urban Runoff

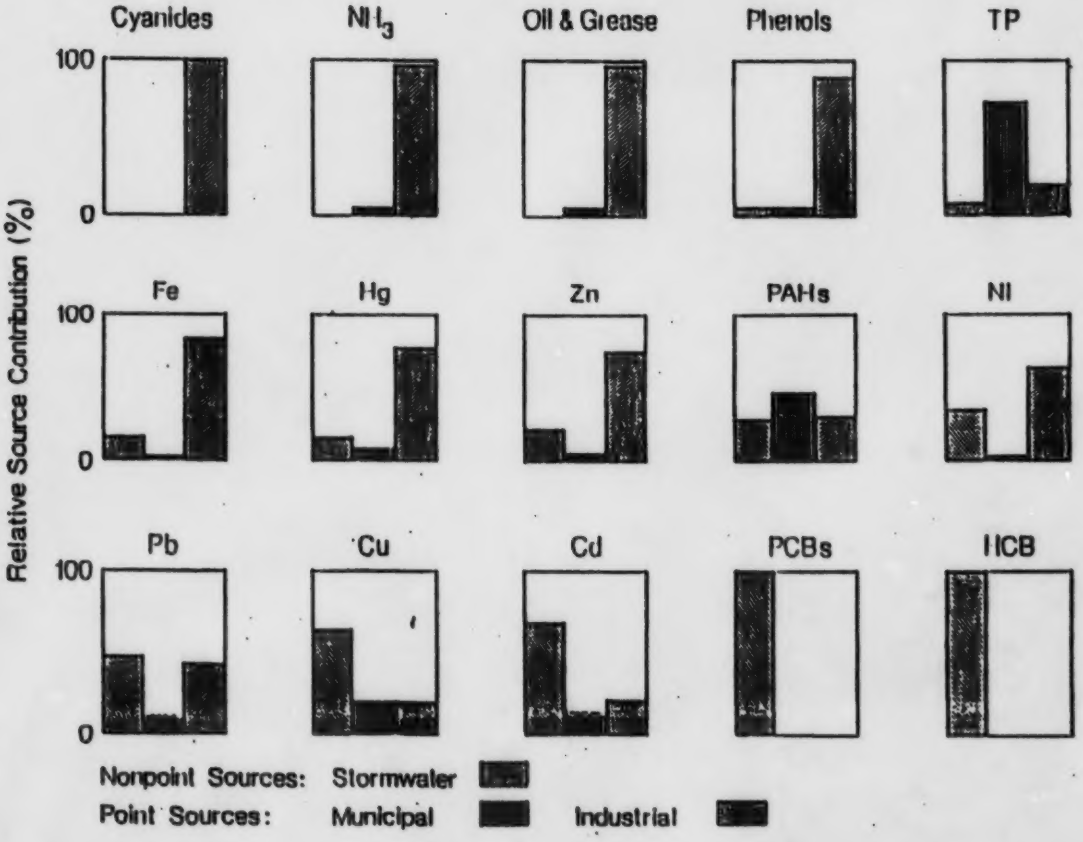
		Concentrations in Urban Runoff				Ambient Water Quality Criteria[3]
		Study Area		Data Bases		
Constituent	Unit	Mean	95% Confidence Interval	NURP[1]	NWRI[2]	
Ammonia (N)	(mg/L)	0.582	0.451 - 0.752	-	-	-
Total P	(mg/L)	0.246	0.191 - 0.318	0.42	-	-
Cadmium	(µg/L)	4.1	3.1 - 5.5	-	1.5	0.2
Copper	(µg/L)	40.9	32 - 52	43	27	5
Iron	(mg/L)	8.72	6.1 - 12.4	-	-	0.3
Lead	(mg/L)	0.155	0.086 - 0.282	0.182	0.146	0.02
Mercury	(µg/L)	0.0283	0.023 - 0.034	-	0.05	0.2
Nickel	(µg/L)	27.1	22 - 33	-	22	25
Zinc	(mg/L)	0.263	0.219 - 0.316	0.202	0.490	0.03
Cyanides	(µg/L)	2.5	1.6 - 4.0	-	-	100
Oil and Grease	(mg/L)	2.56	2.20 - 3.0	-	-	-
Total phenols	(µg/L)	13.7	10.7 - 17.6	-	-	1
HCB	(ng/L)	0.452	0.417 - 0.491	-	8.9	6.5
PCBs	(ng/L)	30.2	21.0 - 43.5	-	13.1	10
PAHs[4]	(µg/L)	6.95	2.6 - 18.9	-	-	-

[1] After U.S. EPA (1983).

[2] After Marsalek and Schroeter (1989).

[3] International Joint Commission and the Province of Ontario criteria for whole water samples (except Hg - dissolved only).

[4] A complete list of 17 PAHs (EPA Priority Pollutants) reported by King (1988).



Relative pollutant source contributions.

From: Reference 2-15

EXHIBIT 2

GREAT LAKES WATER QUALITY POLLUTANTS

I. Parameters for which a Great Lakes water quality problem has been identified

POLLUTANT	PROBLEM		SOURCES				REMARKS
			DIFFUSE				
	Lakewide	Nearshore or Localized	Land Runoff	Atmosphere	In-Lake Sediments	POINT	
Phosphorus[1]	Yes	Yes	Yes	Yes	Yes[a]	Yes	[a] percentage unknown; not considered significant over annual cycle
Sediment[b,1]	No	Yes	Yes[c]	Negligible	Under some Conditions	Negligible	[b] may contribute to problems other than water quality (e.g., harbor dredging) [c] including streambank erosion
Bacteria of Public Health Concern	No	Yes	Minor[d]	No	No	Yes	[d] land runoff is a potential, but minor source; combined sewer overflows generally more significant
PCBs[1]	Yes	Yes	Yes	Yes	Yes	Yes	
Pesticides[1] (Past)	Yes[e]	Yes[e]	Yes	Yes	Yes	No	[e] some residual problems exist from past practices
Industrial Organics[1]	Yes	Yes	Yes	Yes	Yes	Yes	
Mercury[1]	Yes	Yes	Minor	Yes	Yes	Yes	
Lead[1]	Potential[f]	Potential[f]	Yes	Yes	Yes	Yes	[f] possible methylation to toxic form

II. Parameters for which no Great Lakes water quality problem has been identified, but which may be a problem in inland surface waters or groundwaters

POLLUTANT	Lakewide	Nearshore or Localized	Land Runoff	Atmosphere	In-Lake Sediments	POINT	REMARKS
Nitrogen	No	No[g]	Yes	Yes	Minor	Yes	[g] some inland groundwater problems
Chloride	No	No[h]	Yes	Negligible	No	Yes	[h] some local problems exist in nearshore areas due to point sources
Pesticides[1] (Present)	No	No	Yes	No	No	Yes	[i] new pesticides have been found in the environment; continued monitoring is required
Other Heavy Metals	Potential[f]	Potential[f]	Yes	Yes	Yes	Yes	
Asbestos[j]	No	Yes	No	?	Yes	Yes	[j] see Upper Lakes Reference Group Report[37]
Viruses[k]	← No Data Available →					Yes	[k] better detection methods needed
Acid Precipitation	No	No[m]	No	Yes	No	No	[m] a potential problem for smaller, soft water, inland lakes

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[1] Sediment *per se* causes local problems; phosphorus and other sediment-associated contaminants have lakewide dispersion.

From: Reference 2-16

EXHIBIT 3

SUMMARY OF 1976 TOTAL PHOSPHORUS LOADS TO THE GREAT LAKES[a]

	metric tons/yr							
	LAKE SUPERIOR				LAKE MICHIGAN			
SOURCE	CANADA	U.S.	TOTAL	[PERCENT]	CANADA	U.S.	TOTAL	[PERCENT]
Direct Municipal Sewage Treatment Plants[b]	29	39	68	[2]	—	1,040	1,040	[16]
Tributary Municipal Sewage Treatment[c] Plants	38	162	200	[5]	—	1,458	1,458	[23]
Direct Industrial[d]	102	0	102	[2]	—	32	32	[<1]
Tributary Industrial[d]	0	33	33	[<1]	—	247	247	[4]
Urban Nonpoint Direct[e]	16	•	16	[<1]	—	•	•	
Tributary Diffuse[f] (Tributary Total)	1,453 (1,491)	769 (964)	2,222 (2,455)	[53]	— —	1,891 (3,596)	1,891 (3,596)	[30]
Sub-Total	1,638	1,003	2,641	[63]	—	4,668	4,668	[74]
Atmospheric[g]	—	—	1,566	[37]	—	—	1,682	[26]
Load From Upstream Lake[h]	—	—	—		—	—	—	
Total			4,207	[100]			6,350	[100]
Shoreline Erosion[i] (not Included in Total)	0	3,781	3,781		—	3,711	3,711	

From: Reference 2-16

EXHIBIT 3 (Continued)

SUMMARY OF 1976 TOTAL PHOSPHORUS LOADS TO THE GREAT LAKES[a]

	metric tons/yr							
	LAKE HURON				LAKE ERIE			
SOURCE	CANADA	U.S.	TOTAL	[PERCENT]	CANADA	U.S.	TOTAL	[PERCENT]
Direct Municipal Sewage Treatments Plants[b]	107	16	123	[3]	70	5,588	5,658	[32]
Tributary Municipal Sewage Treatment[c] Plants	83	309	392	[8]	185	985	1,170	[7]
Direct Industrial[d]	0	31	31	[<1]	164	111	275	[2]
Tributary Industrial[d]	0	81	81	[2]	0	72	72	[<1]
Urban Nonpoint Direct[e]	16	•	16	[<1]	44	•	44	[<1]
Tributary Diffuse[f] (Tributary Total)	864 (947)	1,564 (1,954)	2,428 (2,901)	[50]	1,726 (1,911)	6,675 (7,732)	8,401 (9,643)	[48]
Sub-Total	1,070	2,001	3,071	[63]	2,189	13,431	15,620	[89]
Atmospheric[g]	—	—	1,129	[23]	—	—	774	[4]
Load From Upstream Lake[h]	—	—	657	[14]	—	—	1,080	[6]
Total			4,857	[100]			17,474	[100]
Shoreline Erosion[i] (Not Included in Total)	131	295	426		5,912	1,024	6,936	

From: Reference 2-16

EXHIBIT 3 (Continued)

SUMMARY OF 1976 TOTAL PHOSPHORUS LOADS TO THE GREAT LAKES[a]

	metric tons/yr							
	LAKE ONTARIO				INTERNATIONAL SECTION OF ST. LAWRENCE RIVER			
SOURCE	CANADA	U.S.	TOTAL	[PERCENT]	CANADA	U.S.	TOTAL	[PERCENT]
Direct Municipal Sewage Treatment Plants[b]	1,079	968	2,047	[17]	84	9	93	[2]
Tributary Municipal Sewage Treatment[c] Plants	155	613	768	[7]	0	54	54	[<1]
Direct Industrial[d]	47	33	80	[<1]	42	0	42	[<1]
Tributary Industrial[d]	4	18	22	[<1]	0	0	0	
Urban Nonpoint Direct[e]	324	*	324	[3]	—	—	—	
Tributary Diffuse[f] (Tributary Total)	1,088 (1,247)	2,169 (2,800)	3,257 (4,047)	[28]	88 (88)	659 (713)	747 (801)	[14]
Sub-Total	2,697	3,801	6,498	[55]	214	722	936	[17]
Atmospheric[g]	—	—	488	[4]	—	—	—	
Load From Upstream Lake	—	—	4,769	[41]	—	—	4,545	[83]
Total			11,755	[100]			5,481	[100]
Shoreline Erosion[i] (Not Included in Total)	777	538	1,315		—	—	—	

From: Reference 2-16

Point Source Control Task Force reported to the International Joint Commission that, with the exception of surveillance, the Governments of the United States and Canada and their respective related States and Provinces had not responded to the PLUARG recommendations.

Since that time, amendments to the U.S. - Canada Water Quality Agreement have clearly indicated the need for urban runoff quality control, and the U.S. EPA intends to issue final Phase One regulations on controlling the quality of storm water discharges under the NPDES Program later this year. Proposed U.S. EPA regulations, first published in December 1988, targeted municipalities with populations of 100,000 or more. Each would be required to develop a water quality management plan to include extensive preparation of inventories, sampling, analyzing and implementing of strategies to improve and control stormwater quality (2-19).

In Ontario, no official commitment has been made towards urban runoff management programs, although the Ontario Ministry of the Environment has made available grant assistance for the development of water pollution control plans for defined urban or rural areas. In addition, programs are in place to assist in curbing beach pollution, which is often attributable to storm runoff or combined sewer overflows, or both.

2.7 Areas of Concern

Annex 2 of the 1987 Protocol of the U.S. - Canada Great Lakes Water Quality Agreement defines Areas of Concern as "geographic areas that fail to meet the general or specific objectives of the Agreement, where such failure has caused or is likely to cause impairment of beneficial uses of the area's ability to support aquatic life". Impairment of beneficial use is defined as a change in the chemical, physical or biological integrity of the Great Lakes System sufficient to cause any of 14 use impairments that include fish tumours, beach closures, degradation of benthos, bird or animal deformities, reproductive problems, and similar effects.

In Ontario, 17 areas of concern have been designated to date, 13 of them at major urban centres. (The remainder are related to major industrial discharges in more remote areas of Lake Superior.) Current IJC policy requires that once an Area of Concern has been identified, a Remedial Action Plan (RAP) must be developed following the guidelines developed by the Great Lakes Water Quality Board. As stated in the Agreement, RAPs "shall embody a systematic and comprehensive ecosystem approach to restoring beneficial uses within the Areas of Concern."

Each Remedial Action Plan must contain:

1. A defined geographical area;
2. A definition and description of the environmental problems to be addressed, including definition of the impaired beneficial uses and the degree and extent of the impairment;
3. A definition of the causes of the use impairment, including a description of all known sources of pollutants involved;
4. An evaluation of remedial measures in place;
5. An evaluation of alternative remedial measures to restore beneficial uses;
6. A selection of additional measures to restore uses, and a schedule for implementation;
7. An identification of the persons or agencies responsible for implementation;
8. A process for evaluating remedial measure implementation and effectiveness; and
9. A description of surveillance and monitoring measures to track the process.

The plan must be submitted in three stages to the International Joint Commission for review and comment:

(a) When the problem has been defined.

(b) When remedial and regulating measures are selected.

(c) When monitoring indicates that the identified beneficial uses have been restored.

Although all RAPs are in process, each with a multi-stakeholder Advisory Committee chosen from within the Area of Concern, progress has been slow. Most RAP teams have submitted their problem definitions based on the five sources of use impairment (air deposition, point discharges, non-point discharges, groundwater leachates, and benthos uptake), but few have finalized their remedial and regulatory plans.

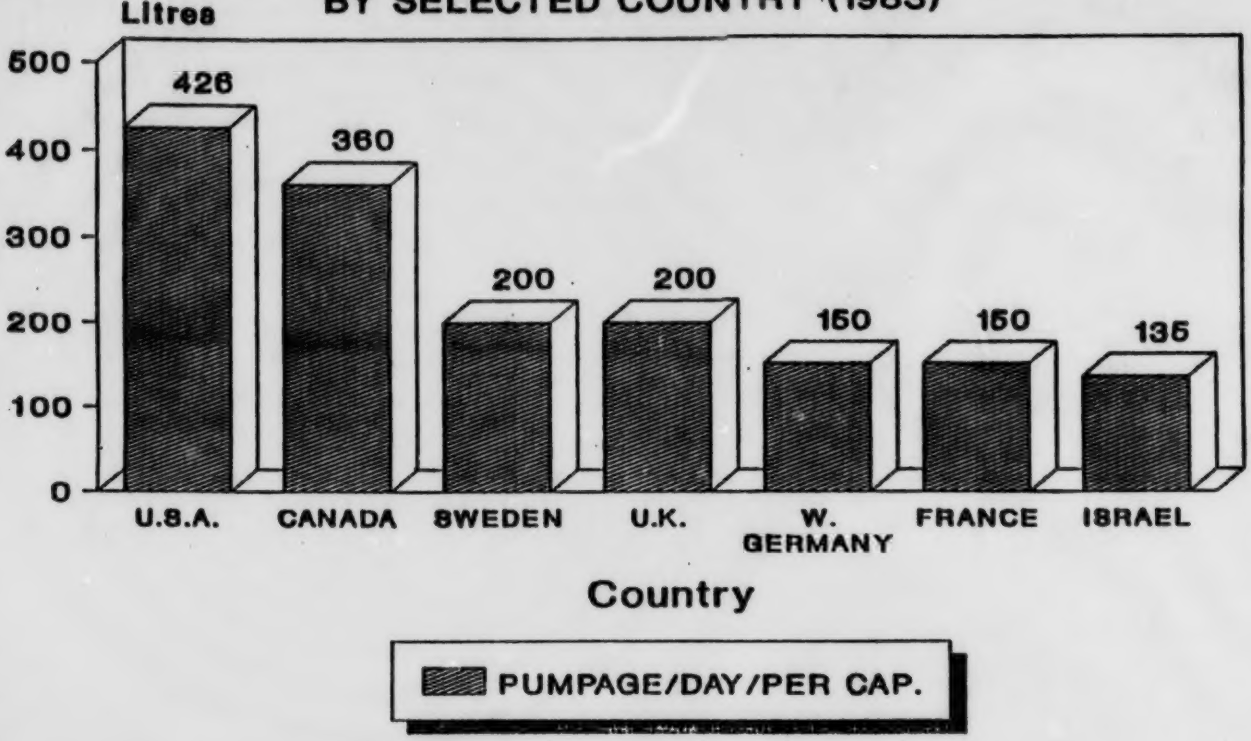
The greatest challenge now facing the RAP teams and their Public Advisory Committees is not in identification of the responsible authority, but rather in finding the money needed to carry out the program. Where costs are significant and the problem is municipal, urban communities insist that the remedial measures are impracticable to solve without senior government fiscal assistance.

2.8 Water Use and Pricing

Canada uses more water per capita than any other country except the United States. In North America, the right to use water has traditionally been awarded at no cost to the user. Urban water supply systems have regularly provided adequate supplies of safe water at a relatively low cost, and without relating costs to volume used. Clearly, these policies encourage wasteful use of water (2-21; Exhibit 4).

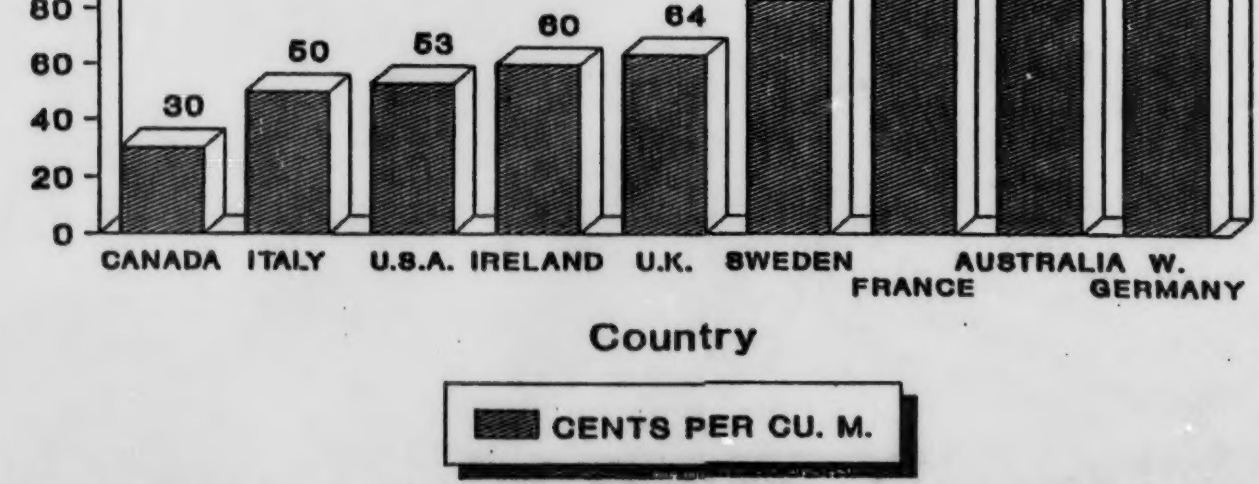
Continuing population growth, increased water demand, stricter regulatory requirements, and the need to control the quality of waste water now place severe pressures on our current systems of municipal water management and supply. Through the development of water conservation strategies in areas such as Kitchener-Waterloo, and increasing awareness of the deterioration of raw water quality in many of our water utilities, we are beginning to realize that, as suggested by the Freshwater Foundation, the consumption of 11,000 litres of water for the preparation of a typical dinner or 570 litres for the production of the weekend newspaper represents a ludicrous level of consumption of an invaluable resource.

EXHIBIT 4



MUNICIPAL DOMESTIC WATER USE BY SELECTED COUNTRY (1983)

SOURCE: TATE, WATER DEMAND MANAGEMENT IN CANADA, 9.



MUNICIPAL WATER RATES BY SELECTED COUNTRY (1983)

From: Reference 2-19

In Ontario and most of Canada, current direct charges for water as outlined in Appendix B are about 75% of real costs. However, since major rehabilitation programs have yet to be initiated for many Ontario utilities, it is probable that if those costs were properly accounted for, actual charges for water service would be about 65% of real costs. Prices for water in Canada overall are 33 to 50% of those in France or Germany, while the per capita consumption on a residential basis is double that of those countries (2-19, 2-20).

Furthermore, less than 50% of municipal utilities meter the supply of water to their residential customers, so that a major sector of the urban population--and more than half the citizens of the Province--are not charged for overuse or wastage of water.

Since many municipalities place sewage service surcharges at an average of 95% of the water supply charge, the inequities of water service charges on related use are compounded in sewer service revenues.

These comparisons emphasize two major defects in Ontario municipal water and wastewater utility operations.

1. **Water is sold to customers and wastewater service provided at considerably less than cost.**
2. **This, combined with a lack of metering, is resulting in wasteful practices that are encouraged by provincial government subsidies.**[6]

In specific terms, there is a crisis in one of Ontario's significant industries. Municipal expenditures represent more than 10% of the provincial gross domestic product, with municipal environmental services accounting for 10% of that. If current investment needs were being met that figure would be double.

More important, this industry has very significant linkages to all other areas of the economy. Neither businesses nor households could function effectively without adequate water and sewage service.

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[6] Current grant and subsidy programs hide the real cost of water supply, and thus do not discourage wasteful practices.

Indeed, current non-conserving water use practices have even greater economic and environmental implications:

- they permit overuse of our water resources and co-incidentally its increased pollution.
- they contribute to the continuing deterioration of the physical integrity of our water and sewer infrastructure.
- they contribute to non-productive government spending through subsidizing wasteful current practices.
- they increase the need for wasteful oversizing of water supply and pollution control works.
- they contribute to unfairness and irregularity in pricing among customer types.

2.9 Provincial Regulations and Enforcement

Recently, the Canadian Institute for Environmental Law and Policy (CIELAP) released an overview of water conservation law and policy in Ontario (2-22); this study was supported in part by funds from the MISA Advisory Committee. The primary objective of the study was to examine the regulatory framework governing water conservation in Ontario with emphasis on the municipal level of government.

In that context, CIELAP analyzed the legal framework pertaining to the development, financing and implementation of water conservation strategies including the mandatory installation of water meters for all customers, full cost pricing schemes, financing of water and sewage infrastructure rehabilitation, reservation of funds from water revenues for conservation, and specific conservation measures such as conserving-type plumbing fixtures.

In summary, the findings indicated that:

1. The Ontario Government does not have a formal water conservation policy. As a result, it does not have a coherent framework to mandate or encourage water conservation generally or with respect to residential customers in particular. (N.B. The Ministry of Natural Resources may soon announce such a strategy).

2. The Province does have a number of mechanisms to encourage water conservation at the municipal level through appropriate pricing of the commodity. These include:

    (a) Conditions attached to MOE permits and Certificates of Approval.

    (b) Conditions attached to approval of the Ontario Municipal Board respecting the financing of water and sewage works.

    (c) Conditions relating to the financing of water and sewage works.

    (d) Conditions attached to agreements between MOE and municipalities, where MOE owns or operates municipal water and sewage works for the benefit of the municipality.

    (e) Conditions attached to Permits to Take Water, issued by the Province for the taking of water from provincial waterways. Such Permits (currently limited to private users) could be extended to include regions or municipalities, with issuance of the permit permit contingent upon a water conservation strategy by the permittee.

3. **At the local and regional municipal level, there appears to be no barrier to these governments proceeding with conservation related pricing practices. There are no legal barriers to instituting metering and reserve accounts for water and sewage works purposes.**

4. **Although current provincial subsidies may encourage low municipal water rates, the conditions could be reversed by requiring water conservation regulations as a prerequisite to provincial subsidy or grants.**

5. **Under the Ontario Plumbing Code the Province has the dominant authority in the area of conservation requirements. The Code could be reformed to require water efficient appliances.**

In summary, the Province appears to have adequate powers to encourage and even demand conservation procedures in the use of water by municipal water and wastewater utilities.

3. CONSERVATION RESPONSE PROGRAMS

3.1 Introduction

The foregoing chapters contain considerable evidence to indicate that the water use practices currently in place in many Ontario municipalities encourage wastage and misuse. These practices have caused a crisis in the water supply and pollution control industry in the Province, creating water wastage, severe water quality degradation, threats to public health and inefficient spending of scarce and expensive money. In many areas, freshwater resources and the systems supplying them are inadequate to meet expanding local demands. Deteriorating municipal water supply systems suffer from significant water losses through water main leakage, while ageing wastewater systems are overloaded due to groundwater infiltration into sewer joints and cracks.

Wastewater treatment plants too frequently have inadequate capacity to cope with current treatment demand, and many plants are failing to meet their effluent requirements due to poor maintenance and operation. As a result, conventional pollutants, nutrients, toxic chemicals and metals are discharged in damaging quantities to our receiving waters. All of these conditions are aggravated and encouraged by inadequate management and finance of our municipal water and wastewater utilities.

It is therefore critical that the Province move to encourage and even demand that municipal water and wastewater utilities adopt sound, conservation-oriented management practices for water supply and wastewater treatment.

3.2 Drinking Water Regulations

There is a demonstrated need to improve the regulatory framework governing Canadian drinking water. Such a framework should be directed in particular at reducing toxics to minimum levels that can be made increasingly stringent with time.

Drinking water treatment technology is on the threshold of dynamic new changes due to a growing consumer demand for zero-risk drinking water. To meet new standards of protection, upgraded treatment facilities such as diatomaceous earth filters and ground activated carbon treatment may be required in some instances. Probably the most fundamental change that will ultimately occur is the substitution of other technologies for chlorination in the disinfection of water[7]. Many systems also will require improved management and operational techniques.

Through the U.S. Safe Drinking Water Act amendments of 1986, Congress required that new maximum acceptable levels and contaminant objectives be established for more than 83 contaminants. Another 25 contaminants will be added every three years. In addition, and regardless of compliance with the new target levels, all surface water systems must be filtered and all supplies disinfected. This ambitious initiative will require, as an example, the building of more than 2,000 municipal filtration plants within the decade. (3-1)

Here in Canada, National Health and Welfare continue to procrastinate over the passage of a Federal Safe Drinking Water Act that has been in draft form for more than six years. It was developed with the assistance of the Council of Deputy Ministers of Health in Canada, with a view to encouraging each of the Provinces, including Ontario, to enact similar legislation within two years. Recent election promises here in Ontario suggest that there may finally be a Provincial Safe Drinking Water Act passed, to limit more than 100 toxic compounds initially. Presumably, alternatives to disinfection with chlorine will be required within the decade to reduce the potential risk of trihalomethanes. The Drinking Water Section of the Water Resources Branch has studied several options for controlling the development of trihalomethanes in drinking water. One option involves the substitution of ozonation for chlorination to meet a guideline value of 100 micrograms per litre in the treated water. The estimated cost of this alternative would be $13.75 million over 135 plants (capital costs only). Another option is the removal of trihalomethanes after formation with ground activated carbon or airstripping. These costs would be materially higher than substitution.

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[7] Chlorine can interact with other chemicals in treated water and waste water, creating new compounds of greater toxicity and persistence than either of the "parent" compounds.

In addition, many water treatment plants in Ontario have yet to install or make arrangements for the treatment of sludge derived for sedimentation tanks, upflow clarifiers and filter backwash. Regulations relating to the Environmental Protection Act (309) should soon demand the adequate treatment of these sludges, which contain toxic organic and inorganic (e.g. heavy metal) compounds. Estimates for water treatment, sludge processing and disposal are approximately $500 million for some 210 water treatment plants that have yet to provide these facilities. Operating costs are not available.

3.3 MISA Municipal Program

As indicated in previous Chapters of this report, the Great Lakes Water Quality Agreement as amended in 1987 required Canada and the United States to institute the following municipal programs as soon as practical.

1. Construction and operation of wastewater treatment facilities in all municipalities having sewer systems to provide levels of treatment consistent with achieving phosphorus removal requirements and the General and Specific Objectives.

2. Provision for financial resources to assure prompt construction of needed facilities.

3. Establishment of construction and operating standards of these facilities.

4. Establishment of pre-treatment for all industrial plants discharging waste into publicly-owned treatment works.

5. Development and implementation of practical programs for reducing pollution from storm, sanitary, and combined sewers.

6. Establishment of effective enforcement programs to ensure that the above pollution abatement requirements are met.

In response to this requirement, the Ontario Ministry of the Environment introduced in 1986 the "Municipal and Industrial Strategy for Abatement" (MISA). MISA's ultimate goal is the virtual elimination of persistent toxic discharges to the Great Lakes through legally-binding effluent standards set separately for eight industrial sectors and the municipal sector. Effluent limits would be determined by Best Available Technology (BAT) for the sector or a water quality impact approach, whichever was more stringent.

In September 1988, MOE issued a White Paper entitled "Controlling Industrial Discharges to Municipal Sewers", describing the Ministry's approach to the virtually elimination of discharges of toxic chemicals from municipal sewage treatment plant effluents. Based on these directives, the municipal program in Ontario is anticipated to include:

1. **A Sewer Use Regulation to be issued by MOE that would set out objectives, catalogue all direct municipal industrial discharges, set control requirements, enforcement procedures, and scheduling.**

2. **A Municipal Enforcement Program (to be enacted by some 90 municipalities initially based on the Provincial Sewer Use Regulation). 5 demonstration programs in Hamilton, Thunder Bay, Cobourg, Ingersoll and Gananoque are currently underway to demonstrate the practicability of this program.**

3. **A Municipal Sewage Treatment Plant Effluent Limits Regulation to be issued by early 1993 that will set effluent limits regulations to which all plants must conform as a minimum.**

To advance this program, the MISA Advisory Committee has recommended to the Minister:

1. **The immediate implementation and/or upgrading to secondary treatment at all municipal STPs in Ontario not providing an equivalent level of treatment now, or inadequate in capacity to provide it properly.**

2. **To protect the operation of these plants, to ensure effluent limits are met, and to reduce toxics in the treatment plant sludges, the introduction, as soon as the demonstration programs permit, of a municipal pretreatment program to limit toxics discharged to the sewage system.**

3. **Provision of nitrification or nutrient removal facilities in instances where specific water quality objectives will be exceeded by STP effluents.**

4. **Introduction of whole effluent toxicity testing on a continuous basis to measure toxic removal compliance.**

5. **Treatment of removed sludges to adequately control the contaminant toxics.**

6. **Improved management and operation of sewage works utilities to ensure continuously effective effluent limits including the training and certification of all levels of participants.**

The foregoing program cannot be completed without the outlay of considerable capital dollars and substantially increased operating costs. Estimates prepared by the Project Engineering Branch of the Approvals and Engineering Division of MOE and the MISA Advisory Committee suggest the following:

- Implementation of secondary plants - $2.0 billion (Capital)
- Upgrading currently inadequate secondary plants - $1.5 billion (Capital)
- Implementation of sewer use programs - $20 million (Operating)
- Nitrification or ammonia removal - $1.5 billion (Capital)
- Improved sludge treatment - $1.2 billion (Capital)
- Management and operation improvements - $15 million (Operating)

Without improvements in plant capacity to control ammonia in the effluent, it would be impractical in most instances for STPs to meet whole effluent toxicity requirements. This is an issue that has yet to be settled and, like the sludge treatment issues, related cost estimates are therefore tentative.

3.4 Rehabilitation

In Chapter 2, evidence was provided to indicate that the current replacement value of water and sewage infrastructure in Ontario municipalities was in the order of $6,800 per capita served.

Reference was also made to the report to the U.S. Congress by the National Council on Public Works Improvement (2-6) (Feb.1988) which found that:

> **A national water supply "infrastructure gap" of the magnitude that would require a substantial Federal subsidy does not exist. Water utilities experiencing revenue shortfalls generally do not charge rates which cover full costs of the utility.**

Various estimates have been made of the increases needed in Canadian municipal spending on infrastructure rehabilitation to ensure continued satisfactory operation and increasing standards of service.

The 1984 survey conducted by the Federation of Canadian Municipalities (2-7) found that funding shortages were the overwhelming impediment to rehabilitation programs, adding that prolonged public involvement in the decision making was the major concern because of the potential delays involved.

It is therefore clear that municipal infrastructure in Canada, now approaching 50 years of age, is not supported at the level needed to maintain its physical integrity. The problem is most severe in small communities (populations less than 15,000), where the lack of rehabilitation programs has allowed substantial deterioration infrastructure to occur.

Continued delays can only make the situation worse. Staggering replacement costs--the estimated investment in Ontario water and sewage systems is currently $6,800/capita--may be incurred if those systems require replacement.

The experience of the Ministry of the Environment's Lifelines Grants Program clearly demonstrated that municipalities are interested in undertaking needs studies to determine the actual physical state of the infrastructure. However, faced with the disclosure of those needs, too many municipalities are delaying the needed expenditures, as shown by a demand for only two-thirds of the available capital subsidy in the 1989 Lifelines Programs.

Traditional engineering estimates suggest that municipalities should be investing 1% of the replacement value of water and sewer infrastructure annually to ensure a service life of 100 years or better. Here in Ontario, it is estimated that for water and sewer systems combined that 1% would approach $500 million annually. Only about 40% of that, at best, is currently being spent. On that basis, an additional $300 million per year, or about $40 per capita served per year, is required if these systems are to be adequately maintained and rehabilitated.

3.5 Management and Operation

Two of the principal factors contributing to the effectiveness of a water or sewage works utility are its daily management and operation, and the government policies that pertain to those functions.

In Ontario, as elsewhere, there is a need to maintain and upgrade standards of management and operation to meet the more sophisticated requirements of water and wastewater treatment, and the operation of a sewer use program with industrial customers.

In noting that a "national problem does exist for small water and wastewater systems", the U.S. National Council on Public Works Improvement in May 1987 (3-2), concluded that the majority of small systems are poorly managed. We have no reason to believe that a similar condition does not exist in Ontario.

Management Audits

One way to assess the adequacy of a utility's management and operation and to institute a program for improvement is through a management audit undertaken by the regulatory agency (Municipal Affairs and/or MOE) (3-3). This approach is most effective if the audits are mandatory and the audit process is consistent. Guidelines set down by the regulatory agency are useful in achieving consistency.

Guidelines for a total utility audit have been set out for World Bank projects (3-4), and serve as a useful framework for establishing a provincial program. The World Bank model can be broadened to include all functions of the utility including customer relations and planning as examples.

Operator Training and Certification

As discussed in Section 2.5, one of the most critical areas in utility performance, particularly treatment plants, is the adequacy of the day-to-day system operation.

Not all deficiencies in plant performance can be blamed on plant operation, but in 1980 the General Accounting Office of the United States Government reported that 50 to 75% of the nation's water treatment plants were in violation of discharge standards (3-5), and about half these plants were not treating wastewater adequately because of deficiencies in operation. The most prevalent problems in this area were inadequate operating budgets and under-trained operating staff.

To address the latter problem, U.S. EPA now supports stronger training and certification programs, improved work schedules, and incentives to encourage employee interest and productivity. (3-6)

In Ontario, the Board of Certification for Water and Wastewater Plant Operations has worked industriously to provide the Minister of the Environment with Operator Certification Programs. On March 20, 1990, the Minister announced that current draft regulations for operator certification would be formally enforced by October 1, 1991. The regulations require that all plants be staffed with certified operators, and provide for four operator ranks, all of which require a formal training program with examinations. A restricted certificate will still be available based on experience only for older operators, but it would not certify them as qualified to operate except in the plant in which they are currently employed.

The new regulations will be issued under Section 44 of the Ontario Water Resources Act and have been developed with the knowledge of the Ontario Federation of Labour and specific unions, such as CUPE. Further work is underway in preparing manuals on owner/operator responsibilities, standards of operation, and similar matters.

The costs of management audits, certification and upgrading of plant operation are difficult to estimate. It is probable that costs will range from $1 to $2 per capita served annually, although improved productivity resulting from these procedures may offset those costs.

3.6 Urban Runoff and Pollution

There is a very real need to expand the MISA municipal sector to provide for the control and treatment of Combined Sewer Overflows (CSOs). Indeed, Canada and Ontario under the Great Lakes Water Quality Agreement are committed to the "development and implementation of practical programs for reducing pollution from storm, sanitary and combined sewers".

The system management strategies of U.S. EPA Region V (which governs all Great Lakes States except New York and Pennsylvania) are probably most applicable to Ontario. In any case, it is unlikely that the Parties to the Agreement will allow Ontario municipalities to take any less action in the long term than their U.S. counterparts (2-13). The following discussion is therefore based on an application of the Region V strategies to the Ontario situation.

Phase I of the Region's CSO strategy requires state (provincial) agencies to include in NPDES permits (Provincial Certificates of Approval) for communities served by combined sewers:

- a re-opener clause to allow modifications to the permit for CSO management

- identification of all CSO discharge points
- prohibition of dry weather discharges that are not in accord with by-pass provisions of the permit
- prohibition of the construction and extension of combined sewers
- a review and modification of existing sewer use by-laws to ensure compliance with EPA Region V Policy
- a maximization of flow volume to the POTW (municipal STP) during runoff conditions
- development of a maintenance program to complement the operational plan
- a program to regularly monitor key hydraulic control points within the system
- an analysis of alternative means of either reducing flow or increasing sewer system capacity to contain CSOs, and
- the submission of a status report on the permit provisions relating to the control of CSOs

Under Phase II, EPA Region V Policy recommends that the permittee be required to:

- conduct CSO and stream monitoring to assess receiving water quality impacts from CSOs
- develop and submit a CSO control plan
- develop an effective sewer rehabilitation program
- update the operational plan to agree with Phase II requirements, and
- provide a construction schedule for implementation of the control plan and the resulting improved effluent limits

The reaction of affected cities to EPA's new requirements on CSOs has been to form a "CSO partnership" to lobby government for more flexibility in the regulation plus federal funding to assist in CSO control costs (3-7). Some observers contend that controlling CSOs could become America's most expensive public works program.

Experience in Chicago and Milwaukee[a] indicates that capital costs for CSO control can be in the order of $1,000 to $2,000 per capita served. Studies in relation to CSO control in the City of Toronto have revealed similar costs. Indeed, the 1989 Report of the City of Toronto Commissioner of Public Works states that controlling CSOs and stormwater overflows to once per year for the City of Toronto would require off-line storage, in-line storage, and increased treatment plant capacity estimated at a capital cost of more than $2 billion.

Detroit has stated that it is impractical to control CSOs in that city, noting that the costs of controls would exceed any unit figures discussed to date.

It is very difficult to separate the issue of CSO from the additional problem of stormwater overflow control. In many systems, the two problems are intimately intertwined.

It appears impractical to consider critical CSO control, including the cost of treating contained flows, at less than $1,500 per capita for capital investment. Presumably, these costs, although largely related to the containment of runoff from surfaces and not the creation of wastewater, will be borne on the water and wastewater utility bill.

In the case of stormwater, reference has been made to the fact that the U.S. EPA has formulated draft guidelines for Phase I of its Stormwater Management Program for municipalities that will be similar to Phase I of Region V's requirement for CSOs. The actual control procedures will equate to, or exceed, unit costs anticipated for CSO control (i.e. $1,500 per person of capital). Implementation of these measures will presumably occur within the next several years. Ontario can anticipate a similar program some time in this decade.

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[a] Chicago has had a deep tunnel scheme under construction for more than 10 years; it is still far from complete. A similar program is underway in Milwaukee.

Cost assessments for the U.S. EPA program will not be based on water user charges but on property. Runoff varies according to the imperviousness and area of contributing surfaces, as well as the intensity and duration of rainfall. The pollution contributed by that runoff therefore relates to the use of the particular property surfaces. For this reason, a number of U.S. cities, commencing first with Boulder, Colorado, and most recently with Cincinnatti, Ohio, and St. Petersburg, Florida (3-8), have established stormwater public utilities where residences, commercial, multi-family and industrial customers are charged a monthly rate for stormwater service. The rate depends on the customer's land use, the degree to which the land is is impervious, and the area of land involved. The advantage of employing the utility concept is to relate costs directly to property benefits and to permit the utility to raise funds on a revenue dependent basis.

3.7 Remedial Action Plans

The Remedial Action Plan approach as applied to Areas of Concern provides a useful framework for the orderly definition of the water resource, its state and uses, the user's impacts, and the corrective procedure needed to restore water quality and user rights. The approach is based on the principle that the river basin or watershed is usually the most appropriate unit for water management. It recognizes the interdependence of watercourse uses and the relationship between land and water development in maintaining and enhancing the ecosystem of the designated region.

Though integrated watershed management has many impediments, including insufficient data, divided jurisdictions, and administrative difficulties, it is an appropriate objective for water policy, as emphasized by the report of the Inquiry on Federal Water Policy (2-2).

The RAP program illlustrates another advantage of the watershed approach, in that it permits a judicious balance between managing water availability and quality against user demands.

Water conservation and reuse are important alternatives to new supplies, and are consistent with global initiatives towards sustainable development and the balancing of economic values with environmental protection.

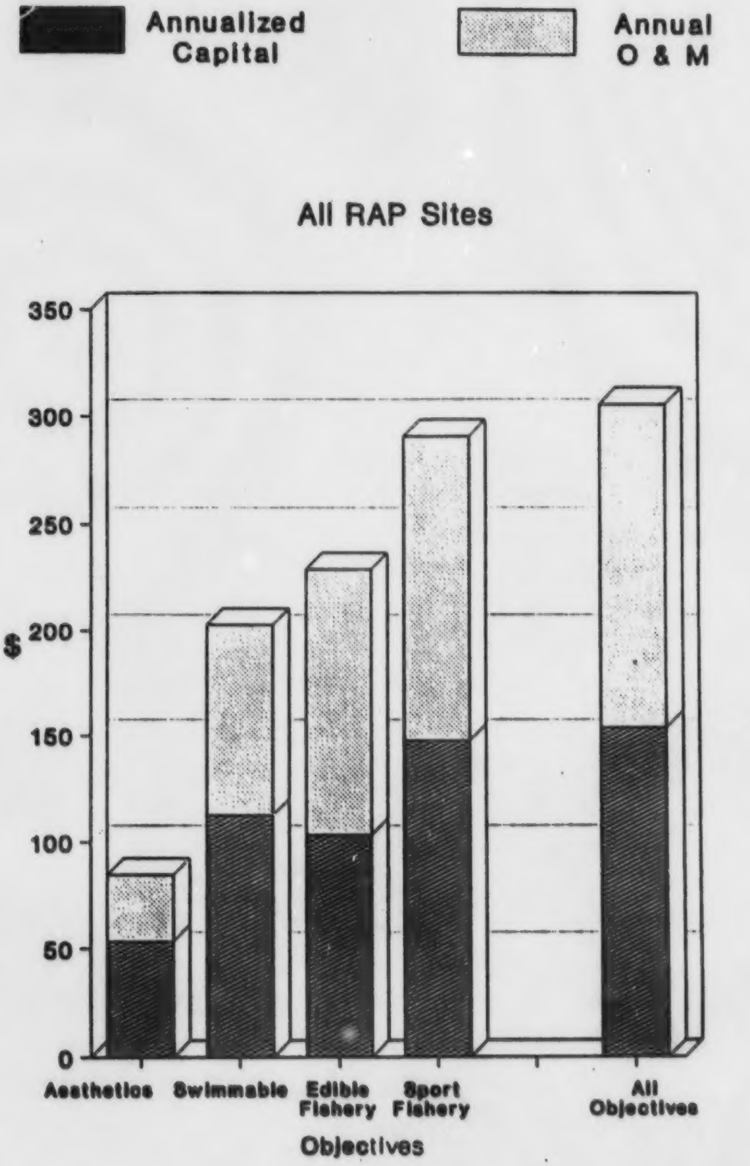
The MISA Advisory Committee feels strongly that based on these principles, the costs of remedial measures under RAP programs can be better assigned to the user. For instance, there can be no doubt that urban water supplies and their treatment, point discharges of municipal wastewater and its treatment, CSO management, and urban runoff control are the responsibility of the municipalities, municipal water consumers and property owners who create the requirement for wastewater treatment. Users of these systems should pay the costs of maintaining and upgrading treatment. Senior government subsidy is not warranted: the user should pay.

Senior governments, however, should be concerned with air pollution deposition and the clean-up of contaminated sediments in Areas of Concern. These complex and multijurisdictional issues are not the responsibilities of municipalities alone. Furthermore, the costs of these programs can be horrendous. The U.S. Corporation of Engineers and Canada Transport and Public Works contend that $10 billion will be required to clean-up the bottom sludges of the 42 Areas of Concern on the Great Lakes (3-9). On the other hand, a provincial study on an economic assessment of Remedial Action Plans for all 17 Ontario Areas of Concern suggested the annual total charges for maximum improvement would not exceed $320 million (Exhibit 5; 3-20). Many authorities consider this estimate substantially less than eventual requirements. In any event, only through a comprehensive designated area approach can issues be revealed and responsibilities and costs identified for corrective action.

EXHIBIT 5

Remediation Costs for RAP Sites

(Millions of 1989 Dollars)



From: Reference 3-20

3.8 Water Conservation Practices, Processes and Devices

3.8.1 Introduction

There is no universally accepted definition of water conservation. Some of the methods used by water utilities (in addition to ongoing public education) involve:

- improving the water yield of their sources of supply
- instituting groundwater recharge
- providing watershed protection from development practices that can cause degradation of both surface and underground supplies
- reducing leakage and other unaccounted-for water
- instituting universal metering
- installing devices to reduce consumption of present and future uses
- recycling of treated wastewater for industrial cooling and irrigation

Indeed the U.S. Water Resources Council has summarized all of this by defining water conservation as "strategies" designed to reduce the demand for water, to improve efficiency in use, to reduce losses and waste of water, or to improve land management practices to conserve water (1-1).

Reduced use of water is essential to control the costs of providing customer service and the use of energy, but probably its greatest benefit is in the reduction of wastewater flows. Reduction of flows not only conserves on plant capacity but more especially reduces use of, and therefore and impacts on, water resources. Reduced water use is central to sustainable development.

It should be noted that the conservation procedures described in the following subsections are not without potential drawbacks. If a conservation program is successful, one of its immediate impacts is the reduction of water and wastewater utility revenues for which the utilities must plan. Also, many conservation programs can be successful under conditions of normal demand but customers may not be capable of further moderation in periods of drought or emergency.

3.8.2 Demand Forecasting

Sophisticated programs are now available to permit utilities to forecast, with land development authorities, water supply and wastewater production. These programs allow unit demands for various users to be combined with pricing, economic forecasts, development projections, weather variables, and sustainable environmental impacts to produce long and short term demand forecasts.

3.8.3 Water Conservation Plans

An effective conservation plan is an implicit part of demand forecasting. It identifies the opportunities to reduce demand, assesses relevant legal and institutional factors, identifies alternative programs, involves a public stakeholders' committee, and provides for public hearings. The following exhibits give excellent evidence of the need for and effectiveness of instituting a water conservation plan.

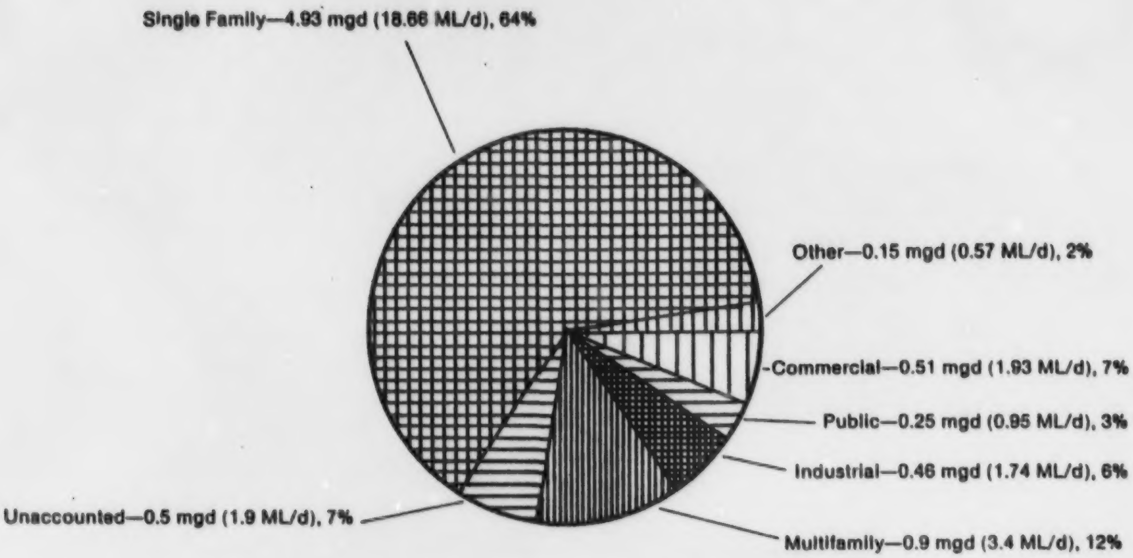
Exhibit 6 provides a typical breakdown of water use according to customer type, indoor/outdoor use, and residential indoor use, and provides some insight into where savings can be made.

Exhibit 7 provides a list of long-term conservation measures that might be considered as a check list in establishing a conservation plan. Although it includes the reuse of treated wastewater, it does not list the reduction of extraneous flows and infiltration into the sewer systems to reduce inflow volumes for treatment at the wastewater pollution control centre. These sources of unaccounted-for water can be substantial in some systems.

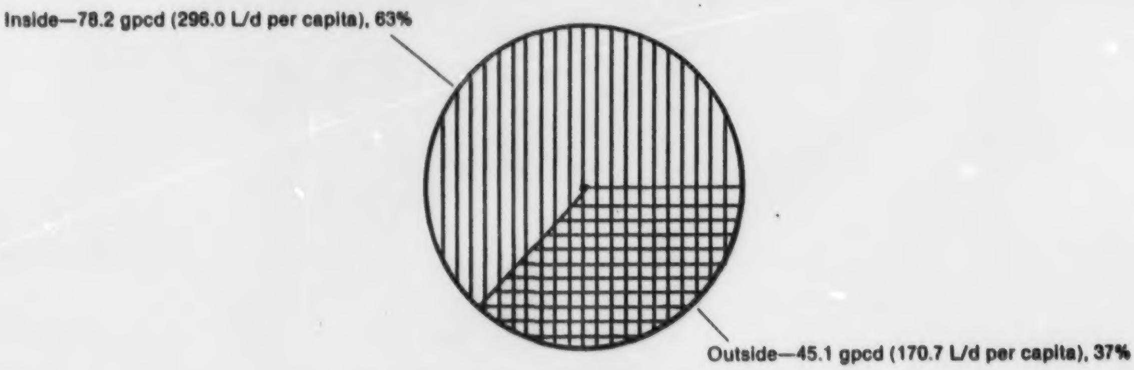
Exhibit 8, from the Urban Water Management Plan for the city of Antioch, California, provides an excellent summary of estimated water and energy savings for 18 structural and operational conservation measures with the related capital cost to dwelling units. Exhibit 9 relates these measures to their use by new and old customers, and shows the associated cost to the utility.

Finally, Exhibits 10 and 11 graphically demonstrate the water savings--virtually a 25% reduction in water use--that can be achieved through the use of water conserving devices.

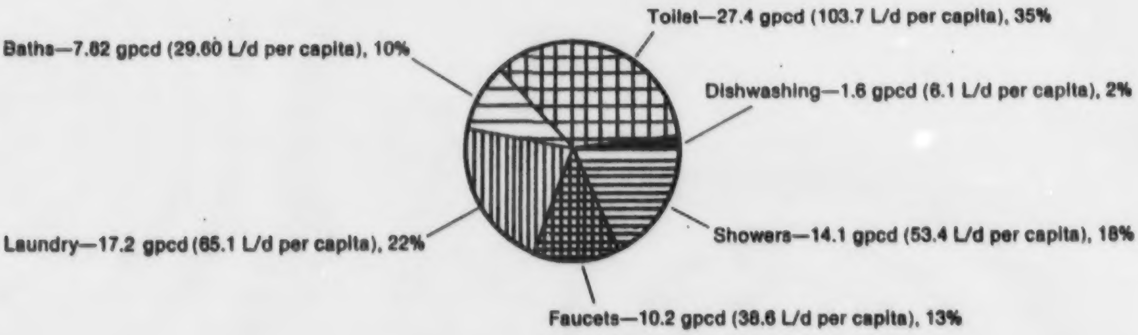
EXHIBIT 6



A. Urban Categorical Water Demand



B. Residential Inside/Outside Water Use



C. Residential Indoor Water Use

Source: Brown and Caldwell (1986).

Typical Urban Categorical Water Sales

From: Reference 3-10

EXHIBIT 7

Typical Long-Term Water Conservation Measures

Area of Application	Conservation Measure
General	Public information
	In-school education
	Metering
	Pressure reduction
	Pricing
	Uniform commodity rates
	Inclining commodity rates
	Seasonal rates
	Leak detection and repair
	System rehabilitation
Interior residential use	Low-flow shower heads
	Shower-flow restrictors
	Toilet-tank displacement bottles/dams
	Pipe insulation
	Faucet aerators
	Water-efficient appliances
Devices for new construction	Low-flush toilets and ultra-low-flush toilets
	Low-flow shower heads
	Pipe insulation
	Faucet aerators
	Water-efficient appliances
Power generation	Recirculation of cooling water
	Reuse of treated wastewater
	In-system treatment
Industrial use	Recirculation of cooling water
	Reuse of cooling and process water
	Reuse of treated wastewater
	Efficient landscape irrigation
	Low-water-using fixtures
	Process modification
Agricultural irrigation*	Off-farm conveyance systems
	Canal lining, canal realignment, canal consolidation
	Phreatophyte control
	On-farm distribution and irrigation systems
	Ditch lining or piping
	Water-control structures
	Land leveling or contouring
	Sprinkler irrigation
	Drip irrigation
	Subsurface irrigation
	Tailwater recovery
	Irrigation scheduling
	Improved tillage practices
	Surface mulches
	Pressure regulator
Irrigation system evaluations	Return-flow systems
	Field drainage
	Main drainage
Landscape irrigation	Efficient landscape design
	Low-water-use plant material
	Scheduled irrigation
	Efficient irrigation systems
	Tensiometers

*Agricultural irrigation conservation practices are not discussed in detail in this book.

From: Reference 3-10

EXHIBIT 8

Unit Cost, and Water and Energy Savings per Conservation Measure

Measure Number	Conservation Measure/Device	Water Savings *gpcd* (L/d per capita)*	Energy Savings *therms/capita/year*	Additional Capital Cost per Dwelling Unit *$*
1	3.5-gal (13.0-L)/flush toilet	8.0 (30.3)	0.0	0.0
2	1.5-gal (5.6-L)/flush toilet	16.0 (60.6)	0.0	100.0
3	2.75-gpm (10.4-L/min) shower head	7.2 (27.3)	12.0	0.0
4	2.0-gpm (8.0-L/min) shower head	9.1 (37.4)	15.0	10.0
5	Low-water-use dishwasher	1.0 (3.8)	2.9	40.0
6	Low-water-use clothes washer	1.7 (6.4)	2.7	50.0
7	Insulate hot-water pipes	2.0 (7.6)	5.8	200.0
8	Retrofit devices	16.0 (60.6)	12.0	2.8
9	Retrofit on resale	16.0 (60.6)	12.0	19.6
10	Water audit, single family	24.0 (90.8)	12.0	0.0
11	Water audit, multifamily	20.0 (75.7)	12.0	23.5
12	Efficient irrigation, single family	7.5 (28.4)	0.0	0.0
13	Efficient irrigation, multifamily	3.7 (14.0)	0.0	0.0
14	Drip irrigation, single family	2.0 (7.6)	0.0	200.0
15	Drip irrigation, multifamily	1.0 (3.8)	0.0	100.0
16	Efficient landscapes, single family	20.1 (76.1)	0.0	0.0
17	Efficient landscapes, multifamily	9.8 (37.1)	0.0	0.0
18	Public education	4.0 (15.1)	0.0	0.0

Source: Urban Water Management Plan, City of Antioch. Brown and Caldwell Consult. Engrs., Walnut Creek, Calif. (Jan. 1986).

*Gallons per capita per day.

This table also shows the energy savings from reduced hot-water use and the additional cost per dwelling unit.

From: Reference 3-10

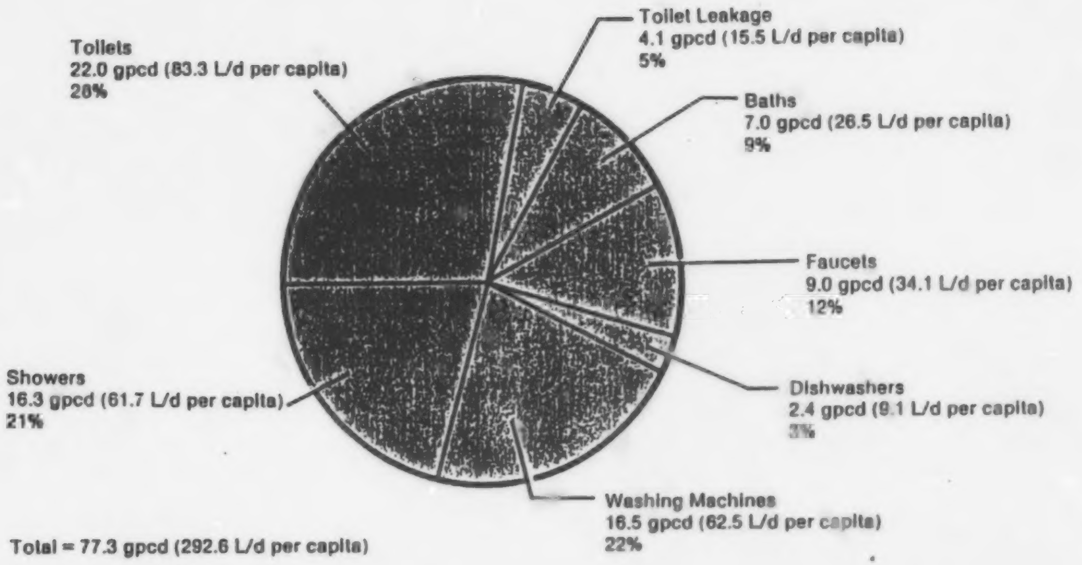
EXHIBIT 9

Projected Residential Market Penetration/Utility Costs of Conservation Alternatives for Year 2005

			Market Penetration		
Alternative Letter	Alternative	Conservation Measures Included*	New Customers %	Existing Customers *% by year 2005*	Water Utility Costs *$/year*
A	Current plumbing code	1,3	100	25	0
B	Advanced devices	2,4,5,6,7	15	0	7500
C	Retrofit devices	8	0	48	19 608
D	Retrofit on resale	9	0	60	10 000
E	Water audits, single family	10	0	75	40 000
F	Water audits, multifamily	11	0	90	13 000
G	Efficient irrigation, single family	12	50	13	50 250
H	Efficient irrigation, multifamily	13	50	13	12 280
I	Drip irrigation, single family	14	25	20	5000
J	Drip irrigation, multifamily	15	50	20	2000
K	Efficient landscapes, single family	16	25	8	50 000
L	Efficient landscapes, multifamily	17	25	8	25 000
M	Public education	18	100	100	25 000

`From: Reference 3-10`

EXHIBIT 10

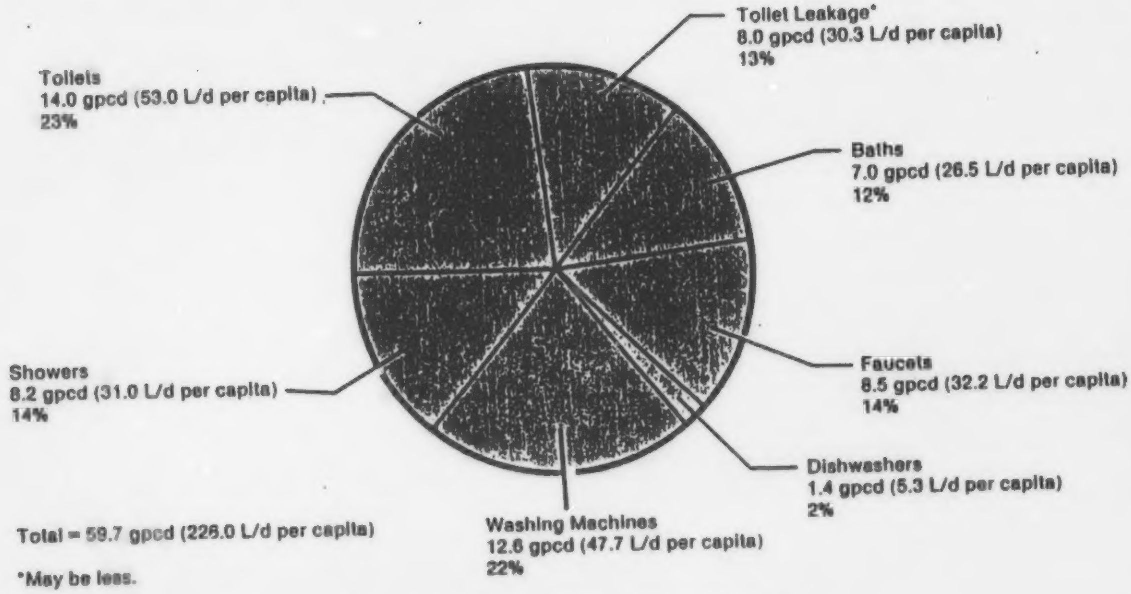


Source: Residential Water Conservation Projects—Summary Report. Brown and Caldwell (June 1984).

Average Inside Water Use for Nonconserving Home

From: Reference 3-10

EXHIBIT 11



Total = 59.7 gpcd (226.0 L/d per capita)

*May be less.

Source: Residential Water Conservation Projects—Summary Report. Brown and Caldwell (June 1984).

Average Inside Water Use for Conserving Home

From: Reference 3-10

3.8.4 Sewer Use By-laws

It is anticipated that the introduction of industrial pretreatment requirements for discharges to municipal sewer systems will have a major impact on industrial water use. Industrial water use in the United States was cut by more than 33% between 1972 and 1982, with the introduction of the U.S. Clean Water Act's provisions for direct discharges. Although, some of the savings could be attributed to energy conservation, tough new sewer use by-laws still reduced industrial waste water usage within municipal utilities to 25% or more.

3.8.5 Adoption of a Water Conservation Plan

The adoption of a water conservation plan by a municipal water and/or wastewater utility is implicit in the development of a regional or urban water management plan, such as the Toronto Area Watershed Management Strategy Study (TAWMSS). Water conservation is only one component of the Water Management Strategy, which together with the management of other water uses and land development planning can permit a comprehensive approach to the sustainable use of water resources.

The cost of a program of the type envisaged here should not be onerous if it is effective, since most savings eventually result in reduced costs to the utility.

3.9 Metering and Pricing

As set out in Appendix D, the combination of effective universal metering with full cost pricing of service to customers can permanently reduce water consumption and wastewater generation by at least 25%. Metering and full-cost pricing also make it possible to charge for customer service on a fair and equitable basis, whether for water supply or wastewater control.

Adequately priced water distributed on a universally metered basis represents an essential aspect of achieving sustainable development in the municipal utility field. It properly links the economic benefits achieved with environmental protection and remediation obtainable through such action. Combined, they represent the single most positive step that can be undertaken in water demand management.

The direct cost of universal metering in Canada has been estimated based on three million meters to be installed at $300 each on average (D-6) or $900 million. It is estimated that more than 850,000 meters must be installed within Ontario utilities alone, equating to a capital cost of $255 million. Financed over 20 years, and provided with high performance automated meter reading systems and an adequate maintenance and testing program, these costs will equate to $6 per year per capita or $20 per year per residential service. Conservation benefits according to most tests should see a pay back within 5 to 10 years.

The current cost of water and wastewater service and the alternatives for designing rate schedules to raise the needed revenues to cover costs of service are discussed at length in Appendices B and C.

In addition, the Canadian Water and Wastewater Association, in consort with the Rawson Academy of Aquatic Science, under the sponsorship of Environment Canada and the Donner Foundation, currently is undertaking an analysis of appropriate water and wastewater rate setting alternatives for Canadian utilities. A complementary study sponsored by the Ontario Sewer and Watermain Contractors' Association and the Association of Municipalities of Ontario, with support from Environment Canada and MOE, is being undertaken in Ontario.

It is hoped that these studies will generate an optimum program for rate setting design that will prove fair and equitable for Ontario water consumers and wastewater generators, while incorporating the necessary conservation measures.

There can be no question that if we are to achieve an effective conservation program in the municipal use of water resources, we must adopt a program of rate setting that will attract sufficient revenue to pay the full cost of service.

Revenue dependency or full cost pricing requires a program of appropriate accounting and legal procedures to be undertaken to establish the full cost of providing service. It is necessary to follow guidelines of the types referred to in Appendix C to separate the utility's costs from the government's general account and to enter into "enterprise fund accounting". This term has been defined by the U.S. National Council of Government Accounting (3-13) as:

> to account for operations that are financed and operated in a manner similar to private business enterprises where the intent of the governing body is that the costs (expenses including depreciation) of providing goods and services to the general public on a continuous basis, be financed or recovered primarily through user charges.

By disclosing the total cost of service, an enterprise accounting system provides the necessary financial information to determine the full cost of service and the extent to which revenue generated from rates covers this cost. It is then possible to establish a fair and equitable set of water and sewer rates directed at raising the needed revenues for the full cost of water and sewage service, including system rehabilitation and expansion.

In support of this concept, an increasing number of utilities are considering single tariff or uniform pricing of their customers as the most appropriate means of achieving fairness and equity among consumers while establishing revenue dependency and, therefore, sustainable use of the water resource.

The system is established on the concept of only one class of user, so that all customers are entitled to the same level of service. There is therefore a single tariff price for water based on volume consumed plus a service charge to cover customer services such as billing, metering, and other fixed costs.

This system, named the "conservation rate", should not provide for fire protection, which is a property benefit, and therefore requires the utility to effect a charge to the rateable assessment of the consumer's property.

Special rates, as set out in Appendix C, may be appropriate to ensure fairness among customers, and seasonal or peak load charges are necessary to any system in order to establish a realistic control on excessive use and wastage of water.

3.10 Future Water Costs

3.10.1 Regulatory Agency Initiatives

In the foregoing pages, the MISA Advisory Committee has outlined some of the current problems that beset municipalities in Ontario with their water and wastewater utilities. We have tried to define the uses and misuses that municipal utilities exert on water resources and have described remedial measures needed now or in the immediate future to correct those impacts, to conserve the quantity and quality of water, and to meet the requirements of sustainable development.

As discussed above, the greatest impediment to water conservation programs is finance. Yet the insidious aspect of the lack of finance is that we are in actual fact using the capacity of our environment to save on direct spending. We are sacrificing the opportunities of future generations with our own greed.

Future water costs must change if we are to adopt the goal of sustainable development. Canada and Ontario have given their support to sustainable development through the National Task Force on Environment and Economy. In its report of September 1987, the Task Force noted that:

> **Current practices should not diminish the possibility of maintaining or improving living standards in the future. This means that our economic systems should be managed to maintain or improve our resource and environmental base so that generations to follow will be able to live equally or better. (3-14)**

The achievement of a "more effective environmental-economy integration" has now become a major initiative of the Ontario Round Table on Environment and Economy which clearly endorses the establishment of full cost pricing in water use and the control of water use through metering. This position is clearly stated in the Ontario Round Table's Challenge Paper, released in July of this year.

A number of agencies are clearly committed to full cost pricing in the future. Environment Canada has in its Federal Water Policy committed itself to the concept of "a fair value for water" and endorses "realistic pricing as a direct means of controlling demand and generating revenues to cover costs" (3-15).

The Canadian Water and Wastewater Association (CWWA), which represents more than 30 major municipal water and wastewater utilities in Canada and is supported by all provincial water and wastewater associations, has indicated its approval of setting water and wastewater rates at full value. CWWA suggested that "utilities adopt pricing strategies that will enable them to cover the fully allocated costs of their systems". The Federation of Canadian Municipalities is considering the possibility of adopting a similar approach.

In the United States, the National Council on Public Works Improvement in February 1988 reported to the U.S. Congress that "water utilities experiencing revenue shortfalls generally do not charge rates which cover the full costs of the utility" and that "users and other beneficiaries should pay a greater share of the infrastructure service". This has prompted the U.S. Environmental Protection Agency to undertake studies of water use and pricing, with a view to implementing changes in pricing policies.

3.10.2 Potential Cost Increases with Full-Cost Pricing

The U.S. EPA evaluations discussed above were undertaken to determine the ability of U.S. municipalities to undertake needed environmental programs without Federal subsidy, which is to be withdrawn as of the end of 1990. Only the benefits of state revolving funds will remain to assist municipal programs.

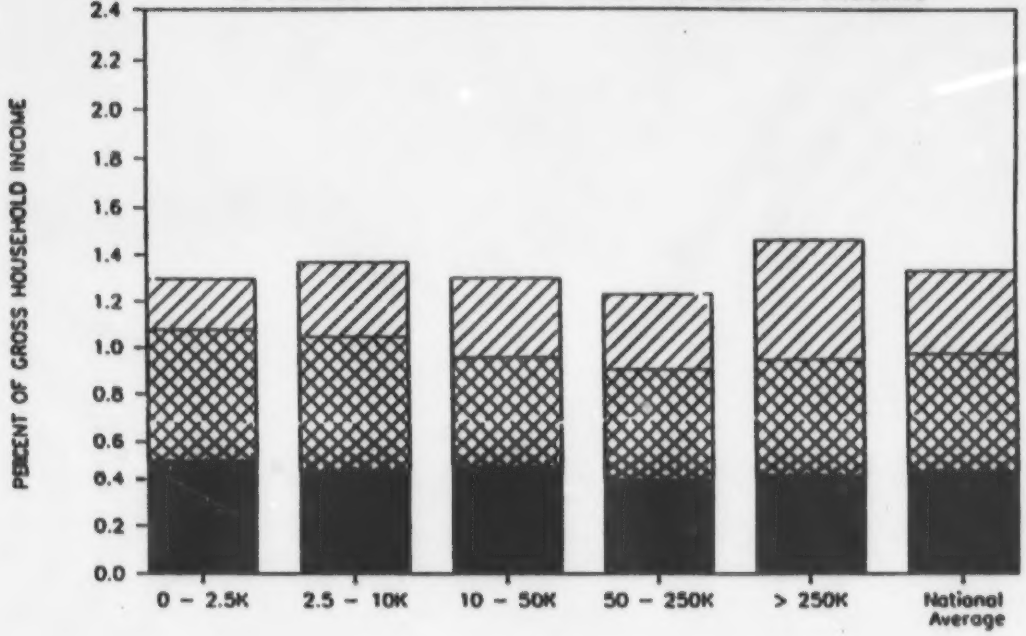
One of the studies was aimed at determining the impact on a typical household of bringing municipal utilities to full cost pricing, and assessing the potential effect of new environmental programs on household costs. The results indicated that the average household (3.2 persons) would spend $120 (Can.) more by 1996 over a current base of $360 (Can.), all based on 1988 dollars. These additional costs did not include provisions for the cost of urban non-point pollution control including CSOs, nor did they include substitution of other disinfectants for chlorine in drinking water treatment. Exhibits 12 and 13 set out graphically these conclusions (3-16).

The study also concluded that most municipalities would be able to meet the expected increases in environmental costs and still remain financially sound. It found that the municipalities most likely to experience difficulty will be those with populations less than 2,500. Here, EPA emphasized the limited margin for expanding financial obligations in small communities due to existing demands for all infrastructure services.

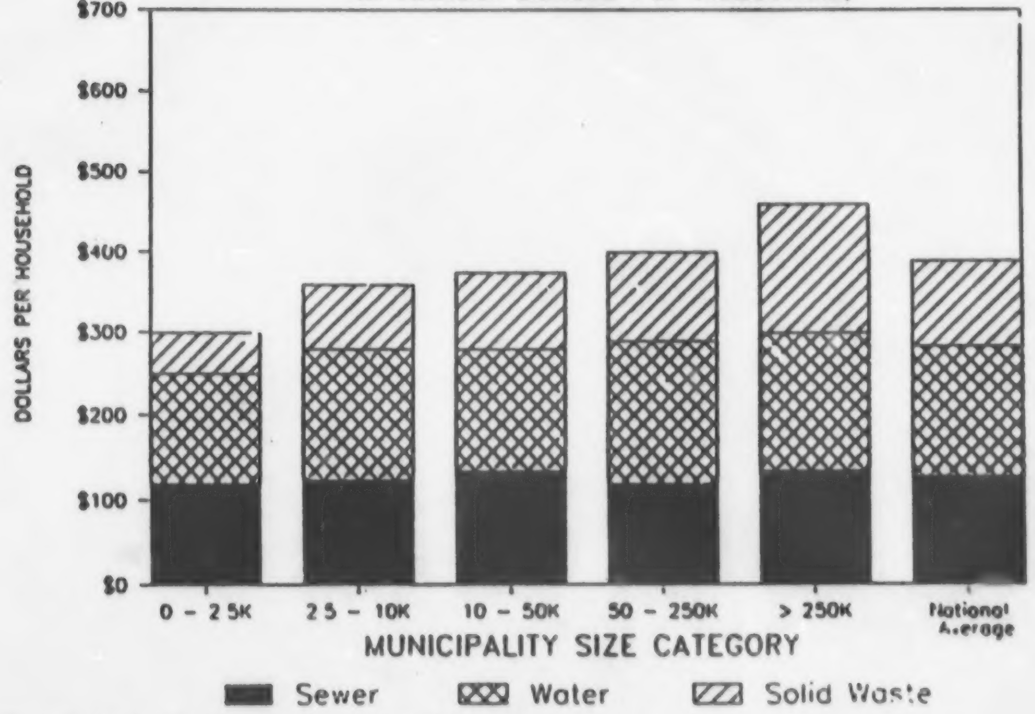
EXHIBIT 12

CURRENT AVERAGE ANNUAL HOUSEHOLD COSTS FOR ENVIRONMENTAL SERVICES

I. Percent of Annual Gross Household Income



II. Annual Dollars Per Household



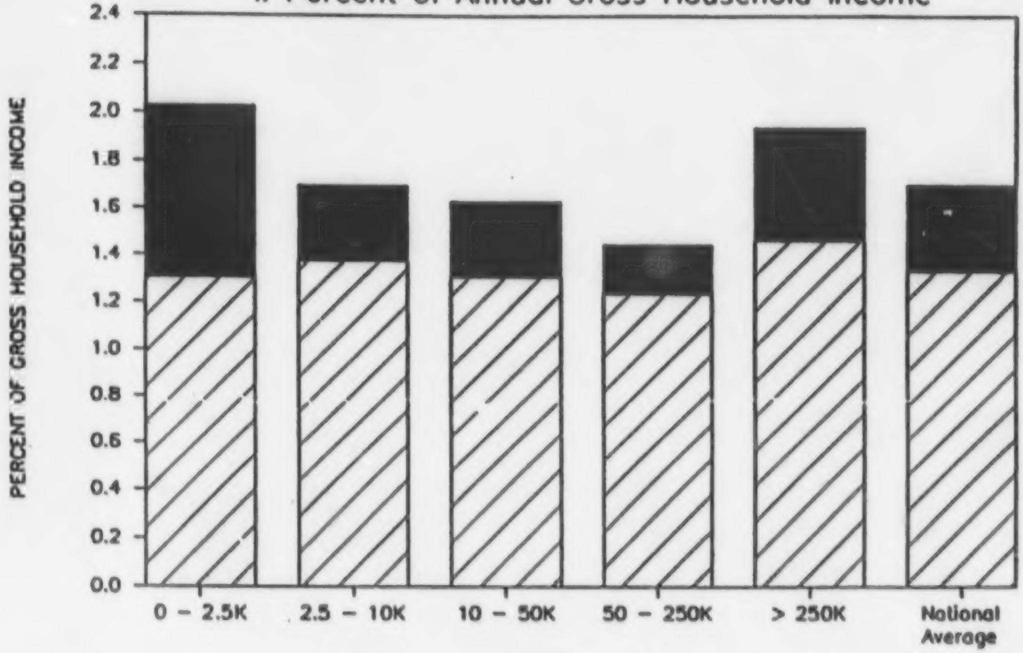
Source: Municipal Sector Study Database

From: Reference 3-16

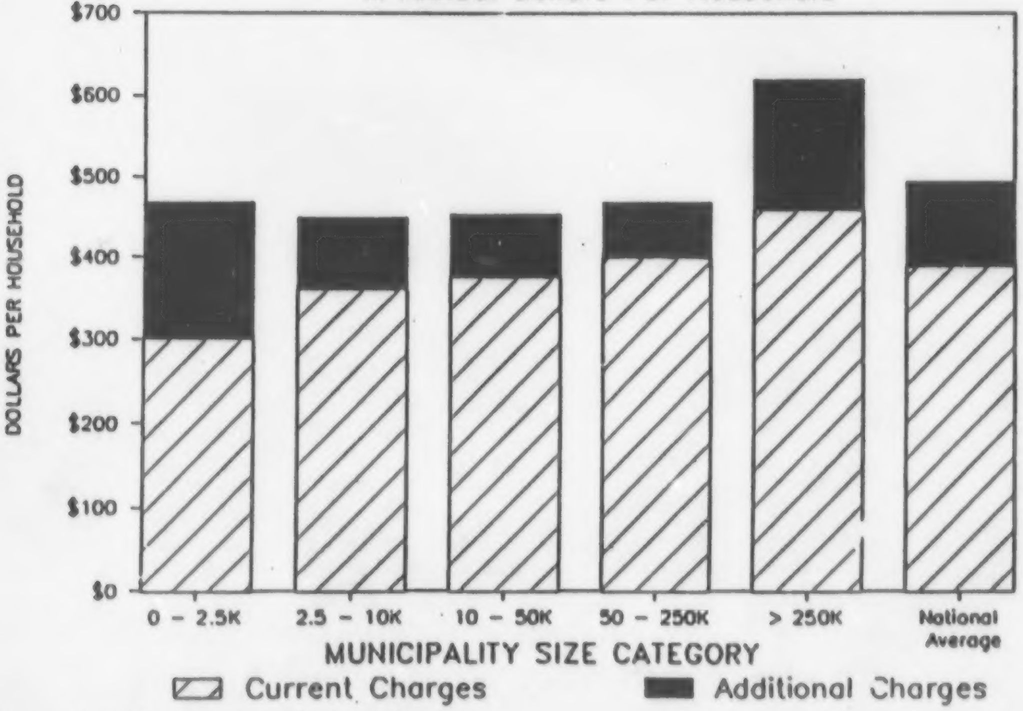
EXHIBIT 13

CURRENT AND POTENTIAL ADDITIONAL AVERAGE ANNUAL HOUSEHOLD COSTS FOR IMPROVED ENVIRONMENTAL SERVICES

I. Percent of Annual Gross Household Income



II. Annual Dollars Per Household



Source: Municipal Sector Study Database

From: Reference 3-16

The study also found that some portion of enterprise systems serving municipalities over 250,000 persons may also have financing difficulties without significant increased support from customer revenues.

Here in Canada, environmental expenditures as a percentage of total municipal expenditures have not increased since 1977. Exhibit 14 indicates that environmental spending ranged from 7.0 to 8.8% over a 10-year period, with expenditure in 1986 being 8.0% for 1986 or $3.53 billion. Statistics Canada figures for 1984 show environmental expenditures at $2.75 billion, made up of $1.25 billion for water, $965 million for sewage service and $558 for refuse and other environmental services (3-17).

In Ontario, environmental spending for 1984 represented $694.5 million for current costs and $349.9 million for capital, for a total annual provincial expenditure of $1,044.4 million (3-17). For the same period that expenditure was broken down to water service at $385.5 million, sewage service at $418.3 million and refuse handling at $240.2 million. Ontario revenues from water, rentals and environment for 1984 totalled $681.9 million or 65% of costs, bearing out continuing concerns over the shortfall in revenue from user charges to cover the full cost of service.

1989 estimates of water and wastewater service charges in Ontario (Appendix B) indicate that the median per capita charges for residential water and sewer service in Ontario are $70 per year, 74% of the $95 it costs to provide the same service per year.

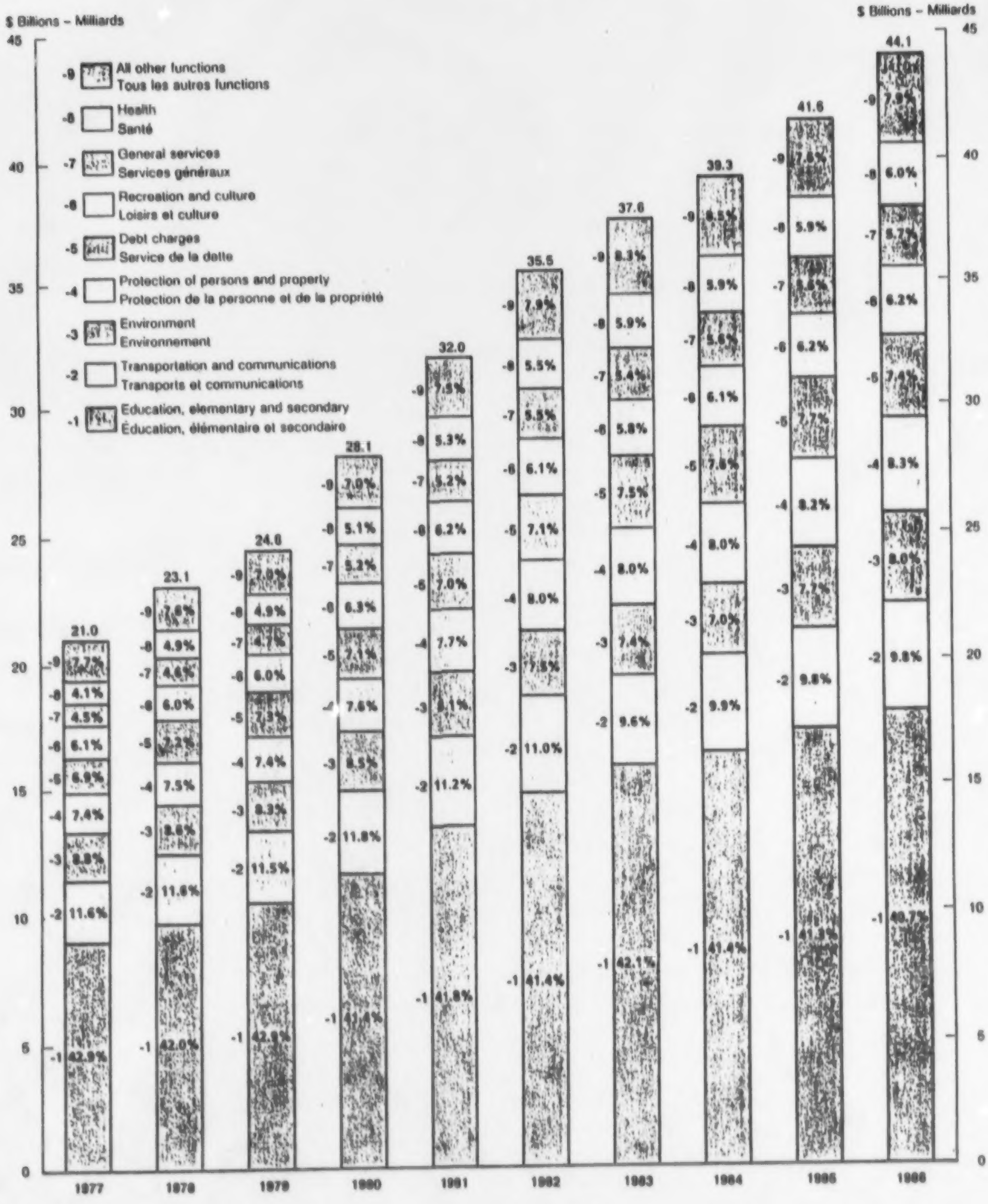
With these figures as a foundation, it is appropriate to estimate the actual charge for water on a per capita basis if revenue dependency were established and allowances for all proposed programs as outlined in this chapter were made. In determining these estimates, we have employed a population served of 7.8 million for water supply in Ontario and 7.2 million for sewage service.

With respect to converting capital expenditures to annual fixed charges, we have employed 20-year debentures bearing interest of 11%. Annual payments on $1,000,000 of capital outlay would be $125,600 on that basis.

The following incremental annual charges can, therefore, be anticipated on a per capita served basis by 2005 based on constant 1990 dollars.

EXHIBIT 14

Distribution of Selected Expenditure Functions, 1977-1986
Répartition de fonctions de dépenses choisies, 1977-1986



From: Reference 3-17

-	Current costs for water and wastewater service	$ 70
-	To establish revenue dependency on a current basis	$ 25
-	Drinking water improvements, water treatment and sludge disposal based on $600 million in capital expenditure and supporting operating costs	$ 12
-	Installed meters at $300 plus reading and maintenance	$ 6
-	Improved management and operation of systems	$ 2
-	Industrial discharge sewer-use control	$ 3
-	Combined sewer overflow control at a capital cost of $1,500 per capita applied to a participating population of 3 million	$ 72
-	Undertaking the MISA Program requirements representing a capital outlay of $6.2 billion plus operating costs	$ 110
-	Rehabilitation based on increased spending of $300 million annually	$ 40
	Potential Estimated Annual Residential Per Capita Charge by 2005	$ 340

All of the foregoing would appear to have the potential to increase residential per capita charges by 500% over current charges for residential service. It should be realized, however, that these costs reflect full cost pricing so that property taxes and subsidies (grants) will no longer be a source of funding.

There is also a need, in setting rates for water and wastewater service, to switch to a two-part tariff to better reflect economic and conservation considerations. This will rebalance the revenues flowing from residential sources, as distinct from industrial and commercial customers who have long benefitted from declining block rate setting. Assuming residential demand to be 40% of total in the average Ontario municipality but contributing to 60% of revenue, the impact of the modified rate structure will be to reduce residential customers revenues to 40% of the source of funds. It is also probable that, over the 15 year time frame, the population served will increase by probably 5% or more.

On that basis, it is reasonable to forecast a rise in the per capita residential charge for water to $250 from the current $70 (or threefold). This increase would occur over a 15-year period and, assuming no inflation, would represent an annual increase of about 8% per annum. The impact would, therefore, be substantially less to the average homeowner than the rapid increase in energy prices experienced in the seventies.

It must be made clear that these estimates are very broad and represent accuracies of plus or minus 25%.

3.11 Public Involvement

Few issues will evoke more public resentment and vitriolic comment than unexplained increases in taxes and utility charges. Nowhere is this process more important than in issues relating to water and water charges. Water is a critical regional issue with the average Ontario consumer. Its impact on his or her daily living is crucial to health, recreation, luxury and accommodation.

Without a committed program of public involvement at both the provincial and municipal levels, major changes to setting rates and water conservation programs will collapse before they are begun. A well informed public and clearly defined structures to channel their participation in the full cost pricing of water and wastewater utility services are essential to assure that management decisions take into account the full spectrum of public values. Effective public participation not only contributes to more effective resource management, but also motivates consumers to accept personal responsibility for the way they use their water resources.

The traditional assumption of water is there is always enough, it's always clean and it's always free. Today's reality is that there is not enough, it is not always clean, and it will never again be free. Under today's circumstances, demand exceeds supply and whenever that occurs, the results are the same: competition among users and higher prices.

Consumers may be willing to pay more for water and sewage services if they are confident that the extra expenditure will result in consistent and high quality service. A recent study of drinking water conducted by the City of Toronto Environmental Protection Office showed a high level of concern among residents about drinking water quality, coupled with a high willingness to pay extra to improve that quality. The median acceptable water bill increase was $25 a year.

How much is water and sewage service worth to us? Is it worth as much as gasoline at 60 cents per litre or even as much as bottled water at 41 cents per litre? Today the average cost to a Toronto consumer is 0.6 cents per litre. If water did indeed cost 25 cents per litre, one egg might cost $140, one loaf of bread $350, and one pound of beef a budget-blowing $4,500 (3-18). There is no question that current water prices are at "bargain basement" levels.

Analogies such as these serve to emphasize the enormous quantities of water that can be wasted with foolishly underpriced water supply and wastewater services. They also demonstrate the need for a public education and awareness program in adopting conservation programs.

In general, we require a province-wide program of public awareness and education to the need for full cost pricing of water, and the dangers that lie ahead if we do not undertake conservation of our water supplies, and the treatment of our wastewaters. The "Participaction" program provides an excellent example of the development of wide public involvement in a program of general importance. It will require personal effort to contribute to water use reduction and to develop the willingness to pay the extra charges that must be levied. Such a program is contemplated in the upcoming initiative of the Ontario Ministry of Natural Resources on water conservation.

In recent years, governments have increasingly sought the views of special interest groups and the public at large before making decisions, especially when they involve natural resources and environmental matters. As indicated in the report of the Inquiry on Federal Water Policy (2-2), this reflects on a growing anxiety about the way we have traditionally used our resources and the environment, deep concerns about the regional and global deterioration of the environment, citizens feeling alienated from their governments, and frustration with the ability of traditional political structures to register public opinion about particular issues and decisions.

Canadians have become increasingly wary of relying on governments and business interests to safeguard the environment and to manage our natural resources. Undoubtedly, well channelled public participation can improve decision making by making decision makers aware of the variety and strength of public attitudes.

Public involvement helps disseminate information, which reduces misapprehensions, polarization and conflict. Open debate improves mutual understanding, promotes the search for compromise, and enhances the credibility and acceptance of the ultimate decision of the program intent.

However, the process has limitations--generating and channelling advice can be arduous and costly for participants and government--and therefore requires careful planning and orderly procedures. It must be credible and it must not only influence ultimate decisions, but be perceived to do so.

The regional Remedial Action Plans (RAPs) made of of public stakeholder groups to involve the public in the development of corrective strategies in the Areas of Concern. There is probably no better model than this in the mounting of a water conservation and full cost pricing awareness program of the type now contemplated by the Ministry of Natural Resources.

The Societal Committee of the Great Lakes Science Advisory Board recently reported to the International Joint Commission (3-19) on the experience with public participation in the Remedial Action Planning Program. They found that adaptability and flexibility in designing regional public participation programs were essential in assuring success. A wide range of approaches including stakeholder groups, advisory committees, public information meetings, and the use of consultant specialists as facilitators were needed to achieve public confidence in the process.

Challenging issues emerging from the experience to date include overcoming problems of credibility and a lack of faith that citizens can influence a decision and the problems associated with rising public expectations.

Exhibit 15, from that study, provides an outline of the goals and objectives for public participation and provides an excellent guide for program design in gaining public acceptance of new charges for water and wastewater services.

EXHIBIT 15

PUBLIC PARTICIPATION AND RAP FRAMEWORK FOR PROGRAM REVIEW - PROXY GOALS, OBJECTIVES AND RELEVANT ACTIVITIES

GOAL	OBJECTIVE	RELEVANT ACTIVITIES
TO INFORM	* Access to information * Assistance in the interpretation of technical data by agency specialist	* Publication of all relevant reports and data
TO INTEGRATE SOCIETAL VALUES WITH TECHNICAL ASSESSMENT	* Develop a program for public participation in consultation with those affected * Commit sufficient resources to the participation program to enable implementation	* Diary of public participation activities throughout the planning process * Indication of budgeted and actual commitments of time, money and staff to participation initiatives
TO BUILD CONSENSUS BY RESOLVING CONFLICT	* Discussion among all interested parties to define a common view of the problem and a means to resolve it	* Employ a wide range of techniques: ° citizen committees ° public meetings ° open houses ° interviews and surveys ° participatory television ° hotline radio ° workshops ° contests and special events
	* Identification and recognition of stakeholders	* Inclusive definition of stakeholders: ° individuals ° property owners/users ° environmentalists ° sportsmen ° farm organizations ° service clubs ° elected officials ° business/industry ° professional ° education institutions, especially school boards and public schools ° labour unions ° news media
TO PRODUCE BETTER DECISIONS	* A process defined from problem identification through to implementation	* Opportunities at critical stages for formal input, review and comment * Opportunity for evaluation and review

From: Reference 3-19

4. ACTION PLAN

4.1 Introduction

In this report, the MISA Advisory Committee has attempted to outline the considerable problems currently created by and for municipalities in their use of the Province's water resources.

We have reached a critical stage in managing municipal use of our water resources. Current management strategies are inadequate to cope with continuing wasteful practices, and the environment is in a dangerous state of degradation, not only because current levels of pollution are already unacceptable, but also because further degradation, through the discharge of toxic and persistent toxic pollutants, is compounding annually.

The current system of municipal water and wastewater management is a "hodge-podge" of arrangements involving public utility commissions, municipal works departments, and provincially owned and/or operated systems. Some are administered and developed as part of a regional plan, while others are in a state of disrepair, existing and developing on an inadequate and poorly planned basis.

Probably the greatest frustration for the political and bureaucratic systems that relate to these plants is inadequate finance. Yet water supply and wastewater systems represent tremendous investments, estimated at more than $50 billion (more than $6,000 per capita served) for Ontario alone. Previous sections of this report indicate that over the next 15 years, more than $12 billion of new capital spending will be required to upgrade these systems to meet new standards of living, to conserve on resources, and above all, to remediate environmental damage and restore the ecosystem. This figure is comparable to a current level of capital spending of $600 million annually.

Publicly acceptable methods must be found to change the status quo and simultaneously provide:

1. Finance required for municipal utility capital expenditures.
2. Effective management of municipal service costs.
3. Reduction of water consumption, water use, and waste generation.
4. Improvement of the effectiveness of water treatment and wastewater management systems.

5. Generation of revenues at or above costs, including capital and interest costs and allowances for depreciation.

A program of this level is mandatory to meet our responsibility to protect public health, to restore and maintain the beneficial uses of water, to meet our commitments to Canada and the United States under the Great Lakes Water Quality Agreement, to maintain the physical integrity and efficiency of an investment of critical value, and above all, for sustainable development.

4.2 Recommended Provincial Initiatives

The Province should move to adopt and implement a Municipal Water Conservation Plan for Ontario, to be implemented over a 10-year period. This plan should be modelled on those currently in effect in California and other American states, but designed to fit the municipal service and environmental protection requirements of Ontario (Exhibit 16).

At the root of this water conservation plan should be two key principles:

- conservation of the use of water, and
- the requirement that the user pays the full cost of service

When water is provided without a price attached to it, users cannot be expected to recognize the value of the resource nor the costs of supplying it and disposing of it safely after it is used. Water is regarded as a free commodity; users lack any financial incentive to economize, and thus tend to use it wastefully. Excessive use creates a need for additional supplies which leads to higher costs and added pressures on the resources.

■ State Enacted Program
▩ Partial State Program
▨ State Enacted Study Proposed Plan
☐ No State Program

	Pub. Ed. / Info.	Plumbing code	Retrofitting	Metering	Leak detection	Rate structure	Contingency planning	Reuse and recycling	Outdoor use	Groundwater management	Industrial use	Agricultural use	Govt. Bldg / Grant Require.
AL	■	☐	☐	■	■	☐	■	☐	■	☐	☐	☐	☐
AK	☐	☐	☐	■	☐	☐	☐	☐	☐	▨	☐	☐	☐
AZ	■	☐	☐	■	☐	☐	☐	☐	☐	■	☐	■	☐
AR	☐	▨	☐	☐	☐	☐	☐	☐	☐	▨	☐	▨	☐
CA	■	■	■	☐	■	▨	☐	■	▨	▨	■	■	■
CO	☐	☐	☐	■	☐	☐	■	☐	☐	■	☐	■	☐
CT	▨	☐	☐	☐	☐	☐	▨	■	☐	▨	■	☐	☐
DE	■	■	☐	☐	☐	☐	■	☐	▨	■	■	■	☐
FL	■	☐	☐	☐	☐	☐	☐	☐	☐	■	■	■	☐
GA	☐	■	☐	☐	☐	☐	☐	☐	☐	■	☐	☐	☐
HI	☐	■	☐	☐	☐	☐	☐	☐	☐	■	☐	☐	☐
ID	☐	■	☐	☐	☐	☐	■	☐	☐	■	☐	▨	☐
IL	■	☐	☐	☐	☐	☐	▨	☐	☐	☐	☐	☐	■
IN	☐	☐	☐	■	☐	☐	☐	☐	☐	▨	☐	☐	☐
IA	☐	☐	☐	☐	☐	☐	☐	☐	☐	■	☐	☐	☐
KS	☐	☐	☐	☐	☐	☐	■	■	☐	■	☐	☐	☐
KY	☐	☐	☐	■	☐	☐	▨	☐	☐	☐	☐	☐	☐
LA	☐	☐	☐	☐	☐	☐	☐	☐	☐	■	☐	☐	☐
MA	■	■	☐	■	■	■	■	☐	☐	■	☐	☐	■
MD	■	■	■	☐	■	▨	■	■	■	■	■	▨	■
ME	☐	■	☐	☐	☐	☐	■	☐	☐	☐	☐	☐	☐
MI	☐	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	■	☐
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NH	☐	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
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From: Reference 3-11

Indeed, the report of the Inquiry on Federal Water Policy indicated per capita requirements for water in Ontario municipalities could double by 2011 if adequate controls are not instituted - a situation that could be critical to Ontario municipal utilities. Coupled with the threat of water loss through global warming which, in turn, would increase water use due to higher ambient temperatures, the situation could change from critical to catastrophic.

Citizens bear both financial and environmental costs in one way or another, though the burden is not distributed among them according to the manner or way in which they use water. A suitable price can create:

- incentives to avoid waste and to use water more efficiently, thus contributing to conservation and sustainable development;
- reductions in the water needed and in wastewater disposal capacity, thereby reducing infrastructure costs;
- lower demand, thereby reducing environmental pressures on water resources;
- conditions for the fair and equitable allocation of costs among customers;
- adequate funds to cover the full cost of needed improvement programs;
- opportunities to relieve the property tax base at the municipal level, and to eliminate the need for subsidy from senior governments who are already in dire financial straits.

In view of all of this, the Committee believes an Ontario Municipal Water Conservation Plan should be developed over the next year by a Joint Program Committee comprised of representatives from government ministries including Treasury, Environment, Municipal Affairs and Natural Resources, and from municipalities, industry, and public interest groups to:

1. Establish a major provincial water conservation information program for Ontario citizens.
2. Set minimum standards for adequate management and operation of water supply and wastewater control systems in Ontario on an integrated basis including:

- cost accounting procedures and allocation methods;
- rate setting procedures;
- universal metering;
- billing and customer service procedures;
- rehabilitation procedures (unaccounted-for-water, sewer infiltration, etc.);
- plant operation procedures;
- training and certification of personnel;
- environmental audit requirements;
- annual reporting;
- provision of model system by-laws;
- outline of urban water resources management plan.

3. Revise the Ontario Plumbing Code to require conserving-type plumbing fixtures and retrofits on new construction and in remodelling of old structures.

4. Establish assistance programs to encourage installation of new fixtures and retrofits in existing homes and buildings.

5. Establishment of a new provincial board or agency, or extensions to the powers of the Ontario Municipal Board or the Ontario Energy Board, to receive and hear applications from municipal utilities on rate revisions and increases, as well as capital borrowing.

6. Preparation and enactment of an Ontario Safe Drinking Water Act with appropriate regulation and the expansion of municipal water treatment plants where required.

7. Broadening of the current MISA Program to require, in addition to the implementation of municipal sewer-use enforcement programs, the upgrading of existing primary wastewater treatment to secondary treatment and the certification of operators as now planned, the following:

- upgrading of all municipal wastewater control plants to meet the proposed Municipal Sewage Treatment Plant Effluent Limits Regulation;
- implementation of sludge disposal regulations;
- introduction of a Combined Sewer Overflow Control Program;
- establishment of a research and development program to support studies on management, administration, operation, rehabilitation procedures, storm sewer overflow control, and similar issues.

The draft programs of the Joint Program Committee should be distributed to the public and hearings conducted across Ontario to determine the response. The revised program should be fully implemented by 1995.

Although unofficial at this time, we believe the draft plan of the Ministry of Natural Resources for a partnership strategy for encouraging efficient and sustainable water use in Ontario accomplishes some elements that we intend in these recommendations. We urge its review and extension to a government-wide "umbrella" initiative with clearly defined roles for each agency and the municipalities.

4.3 Municipal Requirements

In April 1990, the Great Lakes Section of the Water Resources Branch of the Ministry of the Environment prepared a draft report entitled "Inventory of Ontario Provincial Funding Programs Applicable to Remedial Action Plans", which includes also a description of programs available to urban studies such as the Toronto Area Watershed Management Strategy Study (TAWMS).

It listed seven programs sponsored by the Ministry of Agriculture and Food relating primarily to soil and water conservation, several Ministry of Energy programs for assistance for energy from waste, 15 water and refuse related assistance programs by the Ministry of the Environment, a development loans program sponsored by Industry, Trade and Technology, a program for renewal improvement, development and economic revitalization sponsored by the Ministry of Municipal Affairs, a wetlands management program and proposed urban drainage management program sponsored by the Ministry of Natural Resources, and a community recreational development program sponsored by the Ministry of Tourism and Recreation - 35 programs in all. This level of support extends beyond direct water resources management but it does show a high level of unintegrated assistance in the general area of urban water management, and implies provincial government encouragement of comprehensive water and land use planning.

Indeed, it is the MISA Advisory Committee's opinion that the Urban Water Resources Management Plan proposed in subsection 4.2 should incorporate many of the issues to which these assistance programs respond, because of the interrelatedness of development, industrial activity, recreation, and other issues with water use.

On that basis, we see the development and implementation of an Urban Water Resources Management Plan as including the following elements:

(a) A coordination of current land use development, redevelopment and future development with due reference to official plans so as to direct the water management study to follow land use requirements.

(b) An estimate of past, current, and projected water use, and wastewater generation responding to land use, and, therefore segregated according to land use.

(c) An estimate of current urban runoff conditions and future impacts according to current and projected land use.

(d) Identification of the current conditions of water resources within the planning region, and the various uses and impacts relating to different land use and consumer types.

(e) An inventory of water conservation measures currently practiced by municipal water and wastewater utilities, direct industrial users, and urban authorities to control water use, point and non-point water pollution discharges and ground water pollution.

(f) The water management programs necessary to meet the Ontario Municipal Water Conservation Plan and Provincial Water Quality Objectives for the water resources of the planning area while satisfying land development objectives.

(g) The relative environmental and economic impacts of these programs.

(h) A schedule of implementation for the proposed programs.

(i) An outline of the public education and involvement program that would be undertaken prior to submitting the plan for Provincial approval.

(j) A commitment to a regular five-year review of the Plan.

The plan must also require a response to the provisions of the Ontario Municipal Water Conservation Plan discussed in subsection 4.2. Metering, water recycling, wastewater reclamation, water fixture and appliance retrofits, pricing, rate structures, and customer regulations can therefore be included in the measures and programs considered under sections (e) and (f) of the plan.

NOTE: On June 26, 1990, the City of Toronto approved a Water Conservation Plan bylaw that encompasses most of the provisions discussed above.

4.4 Finance

The foregoing action plan requires an additional outlay of $12 billion or more over the next 15 years if there is to be an honest commitment to urban water management and sustainable development.

The revenues to pay for these programs will come from the users and customers of the water and wastewater management systems in the urban planning areas, and from property owners where the programs directly relate to land use.

This report has made it clear that only by users paying the full cost of service on a universally metered basis can we reduce wasteful water use and make progress towards ecosystem restoration. Indeed, the Government of Ontario, through the Premier and the Treasurer, have made it clear in public statements that the Province of Ontario is withdrawing from direct grant programs as they relate to water and wastewater facilities. This will represent the withdrawal of the Province from about $200 million annually in capital transfers to municipalities.

To fill this void and provide almost one billion dollars per year of new investment will not only require substantial increases in revenues from municipal customers as previously discussed, but also will encourage new approaches to municipal finance.

Since many senior governments in the Western world are opting out of local government support programs in favour of "user pay" systems, many new financial alternatives are being introduced for the capital financing of municipal infrastructure.

It is not the role of this Committee to investigate these alternatives in detail. However, certain of them clearly deserve further study by representatives of government, the financial community, and the Association of Municipalities of Ontario.

A recent publication by the Arthur Young Group (4-1) sets out in detail a number of available financing alternatives. The report stresses the value of tax exempt municipal bonds (not yet available in Ontario), leases of various designs, state revolving funds, and public/private partnerships.

Revolving loan funds represent a flexible and powerful government option for financing infrastructure. The common thread through various alternative designs is a base of capital that is loaned to the municipal borrower for use in purchasing an asset, and that upon being repaid "revolves" or is loaned again for another use.

The variety among revolving loans arises in methods for capitalization, operating characteristics, and loan terms. For instance, the loans can be capitalized by grants, legislative appropriations, bond proceeds or user fees; they may be leveraged or unleveraged; they may be issued as loans or grants; and the loan terms or grant matching requirements may vary substantially.

In the U.S., state revolving funds have been popular with both state and local governments because of the wide flexibility they provide in structuring the loan programs. Specific needs can be readily addressed without complicated administrative procedures.

Public/Private Partnerships, sometimes referred to as "privatization", represent private sector involvement in the design, financing, construction, ownership, and/or operation of a facility which will provide services to the public sector. This type of arrangement is one way for the private sector to work with local governments in obtaining and/or operating needed facilities. Arrangements can range from "contracting out" to private financing and ownership of facilities, or providing operation through a service contract. This approach has been shown to be a highly successful alternative to municipally-owned water and wastewater utilities in France and the United Kingdom. The United Kingdom has just committed its 10 regional water authorities in England and Wales to privatization. In the United States, privatization is well established in the waterworks industry, but not in the wastewater control field.

In Ontario, the new Water Services Secretariat apparently will offer a similar service, but as a Crown Corporation and not as a private sector group. In that sense, it will continue the work formerly undertaken by the now defunct Ontario Water Resources Commission and the Ministry of the Environment.

All of these options appear possible and within reach with the Provincial Government's support of a province-wide water conservation initiative. We urge the early review of the Ministry of Natural Resources' proposal "Towards a Water Efficient Ontario", and its extension to include all agencies with mandates affecting municipalities, industry and trade, energy, water quantity, and water quality.

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APPENDIX A

STATE AND PROVINCIAL REGULATION OF MUNICIPAL WATER USE AND PRICING

APPENDIX A

STATE AND PROVINCIAL REGULATION OF MUNICIPAL WATER USE AND PRICING

Prior to 1970, most U.S. States were reluctant to mandate regulatory procedures on the development and operation of municipal water supply and wastewater control systems. However, with the introduction of the U.S. Water Pollution Control Act in 1971, and the requirements it invoked on pricing procedures for municipal wastewater utility systems, this situation began to change.

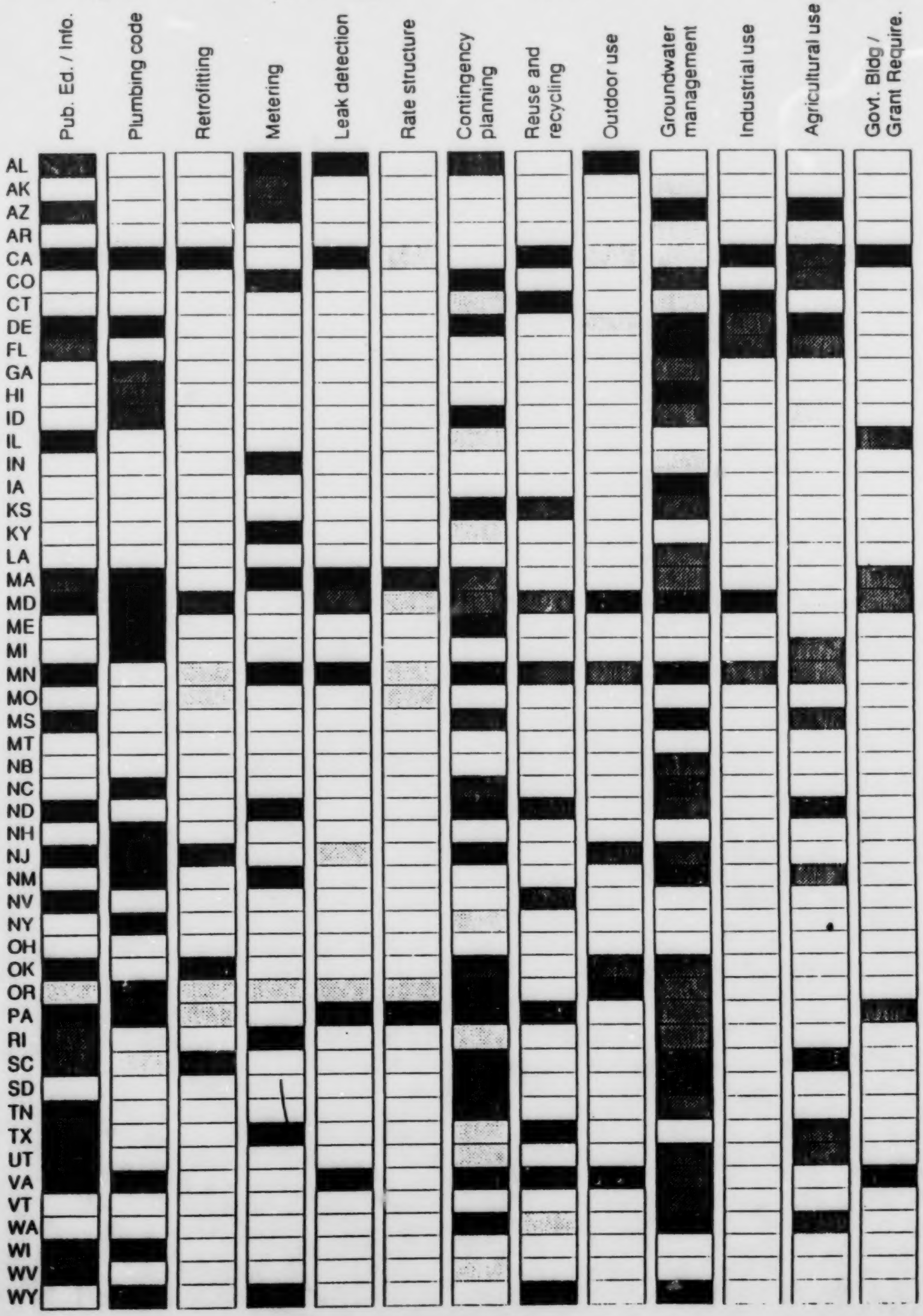
Adding impetus to this was the call for energy conservation created by the OPEC oil rationing of 1973, which resulted in escalating power costs to municipal water and wastewater utilities. These signal factors, coupled with growing evidence of water shortage and quality degradation, encouraged the States first to set guidelines, and later to mandate regulations, for the municipal use of water.

Exhibit 16 shows the result of a 1983 survey of all 50 States to determine the response to 13 different aspects of water conservation (A-1). The results showed that California had the most far reaching program, while Massachusetts, Minnesota, and Maryland had also taken significant initiatives. Even at that time, six states required metering of consumers in municipal systems. The category in which there was the least effort state-wide was in establishing the form of rate structures.

Since that time, many states have moved to strengthen control over the conservation of water, including the regulation of municipal water and wastewater utilities. California has now amended its Statutory Water Rights Law and Related Water Code Sections to define Urban Water Management Planning under the Urban Water Management Planning Act (A-2). The Act requires urban water suppliers to develop water management plans to achieve conservation and efficient use. A plan must be prepared and adopted as an individual municipal plan or as part of an area wide regional watershed-wide or basin-wide urban management plan. The plan must be submitted to the State Water Resources Control Board for review and amendment every five years.

EXHIBIT 10

- ■ State Enacted Program
- ▨ Partial State Program
- ░ State Enacted Study Proposed Plan
- ☐ No State Program



	Pub. Ed. / Info.	Plumbing code	Retrofitting	Metering	Leak detection	Rate structure	Contingency planning	Reuse and recycling	Outdoor use	Groundwater management	Industrial use	Agricultural use	Govt. Bldg / Grant Require.
AL	▨			■	■		■		■				
AK				▨									
AZ	■			▨						■		■	
AR													
CA	■	■	■		■	░		■	░		■	▨	■
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From: Reference 3-11

The Plan must contain at least:

(a) An estimate of past, current, and projected water use according to customer type.

(b) Identification of conservation measures currently adopted and practiced.

(c) Identification of alternative conservation measures which would further improve efficiency of use with their costs.

(d) A schedule of implementation.

(e) Identification of wastewater reclamation programs.

(f) Management of water pressures and peak demands.

(g) Incentives to alter water use practices including fixture and appliance retrofit programs.

(h) Public information and educational programs.

(i) Improvements in pricing, rate structures, and regulations.

The supplier must first make the plan available for public inspection and hold a public hearing on it. When these steps have been completed, the plan must be submitted for state review prior to its adoption.

The California program places the onus on the supplier to develop the plan according to its directives, but does leave flexibility for local implementation of the plan. State wide regulations for retrofitting and plumbing codes are in effect as is the mandatory metering of water. Arizona has regulated even stronger requirements on urban users, as have New Mexico, Utah, and Massachusetts.

Illinois is a Great Lakes state that has enacted "Rules and Regulations for the Allocation of Water from Lake Michigan" - January 1985 (A-3). The need for such regulation was occasioned by the decision of the Supreme Court of the United States to limit the diversion of water from Lake Michigan into the Illinois State Waterway to an annual average rate of 3,200 cubic feet per second.

The regulations require all permittees to:

(1) Submit plans designed to reduce or eliminate wasteful water use, and to reduce unaccounted for flows to 8% or less by 1986, and all years thereafter based on net pumpage.

(2) Practice leak monitoring and correction for all storage, transmission, and distribution systems.

(3) Install meters in all new construction.

(4) Install meters in existing non-metered services as part of any major remodelling.

(5) Adopt ordinances to require the installation of conserving type plumbing fixtures in all new construction and remodelling of old structures.

(6) Introduce public education programs.

(7) Introduce specific requirements related to air conditioning, public lavatories, car wash installations, pollution abatement, hydrant use.

Finally, the Department recommends (and may soon enforce) that all permittees adopt water rate structures based on universal metered water use to discourage excessive water use.

Recently, the Illinois Department of Transportation has required all permittees to have in effect an ordinance with the minimum requirement that unrestricted lawn sprinkling will not be allowed from May 15 - September 15 of each year.

In Canada, municipal water works and wastewater control systems are governed by provincial government policies concerning municipal activities. Most municipalities must seek approval from provincial agencies for at least debenturing debt and possibly even for setting rates. These agencies are primarily concerned with ensuring the solvency of the municipalities and, in doing so, frequently enforce policies contrary to user-pay or a fair and equitable rate base. Indeed, Newfoundland actually sets the rates that may be charged by municipalities to their customers. New Brunswick and Saskatchewan annually review rates. Manitoba publishes guidelines and directly regulates rates. Alberta and Ontario only review rates in the case of complaints or disputes. British Columbia does not regulate, while Quebec, although not regulating, requires all capital costs for water supply and wastewater utilities to be collected through special assessments and not water rates.

Finally, Nova Scotia requires annual reporting and regulates rate levels and structures using rate setting manuals. It finds the necessary authority in the Provincial Public Utilities Act (Chapter 258 of the Revised Statutes of Nova Scotia), and in the rules for the regulations of practice and procedures set by the Nova Scotia Board of Commissioners of Public Utilities, orginally issued in June 1913. The Board has the right to set an appropriate rate of return on assets, fix and determine an adequate rate base, and has the power to force utilities to comply with its orders.

To our knowledge, no province has yet mandated regulations on the control of water use in municipal water and wastewater utilities. The proposed Provincial Sewer Use Program Regulation currently under development in Ontario (designed to eliminate the discharge of toxic materials by industry to municipal sewerage systems under the MISA Program) probably is closest to this goal. However, the proposed initiative of the Ontario Ministry of Natural Resources may form the basis for a government-wide initiative to introduce conservation of water use to the municipal scene.

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APPENDIX B

CURRENT COSTS OF WATER AND WASTEWATER SERVICES IN ONTARIO MUNICIPALITIES

APPENDIX B

CURRENT COSTS OF WATER AND WASTEWATER SERVICES IN ONTARIO MUNICIPALITIES

B.1 GENERAL

Water consumption has increased drastically in the years since World War II, driven by a compounding growth in productivity, as well as, an equal improvement in living standard, and a ridiculously low price for service.

At the same time, the availability of water resources has declined due to loss of quality through pollution and increasing and sometimes unnecessary withdrawals, all of which have resulted in increased utility costs.

Such a condition can create a resource crisis in economic terms which is said to exist when the quantity demanded is greater than the quantity available, and when there is little time on price incentive to adjust either of these (B-1).

Because of the general abundance of water, water policy has evolved since Confederation as if water had no significant cost and there were no limits to its availability in quality as well as quantity.

Politics and not economics have been the driving force behind setting water prices in relation to use. The user charges across the country are ridiculously low and customers are frequently paying more for cable television or bottled water than they are for water and sewer services. Public ownership of our water and wastewater utilities has encouraged all of this. Our original municipal supplies were privately-owned but their inadequacy in protecting the public health, the need to provide capacity for public fire protection, and their low returns on investment resulted in public ownership.

This provided the opportunity for provincial and municipal politicians to subsidize the real cost of water to their customers, to encourage development, and win favour.

Today, the costs of water supply and wastewater services are coming under pressure of new environmental standards, inflation, interest rates, water wastage, and high energy costs. Revenues collected directly from the users fail to meet these new costs. To some degree the shortfall is made up of subsidies, subdivision contributions, and property taxes. Too frequently, however, needed works such as system rehabilitation and maintenance are left undone.

The cost of water supply and waste water treatment must be put in the context of the cost of other utilities such as natural gas, electricity and telephone. People need to be aware of what water costs in comparision to other services, so they can make their own judgement on its relative worth and the need to conserve it (B-2).

To demonstrate the current incongruity of water costs versus user revenues, the following analyses has been prepared.

B.2 WATER COSTS AND RATES

There were in Ontario as of January 1st, 1987, 453 municipal water systems with 134 either owned or operated by the Ontario Ministry of the Environment. However, a number of these systems were supplied from a central source and treatment system so that only 368 separate municipal supply systems existed.

Correspondingly, 415 municipal waste water systems existed at that time (excluding 3 commercial septic tank systems) of which 231 were owned and/or operated by the Ministry. Again a number of these systems relied on a central collection and waste water treatment system, so that only approximately 282 separate pollution control centres existed.

Virtually all systems are publicly financed but as indicated earlier, the direct charges to the users rarely reflect the real costs. Indeed there is no reliable provincial or national data available to determine the extent to which users pay the cost of water supply and waste water management services.

In a national survey undertaken by the Federation of Canadian Municipalities in 1984 (B-3) data obtained from 30 to 50 larger Canadian municipalities revealed, as set out in Exhibit B-1, that the source of funds to support the cost of service for water was primarily derived from user fees (about 84 percent), but for sewage collection only 53.5% was derived from that source increasing to 83% for waste water treatment.

Exhibit B-1 - SOURCE OF SUPPORT FUNDS

	Sewage Collection	Sewage Treatment	Water Distribution	Water Treatment
	%	%	%	%
General Tax	29.6	7.5	4.7	4.5
User Fees	53.5	82.3	85.5	82.7
Debt	11.7	6.3	8.5	11.8
Provincial	4.5	2.5	1.1	0.9
Federal	0.0	0.7	0.1	0.0
Other	0.6	0.4	0.2	0.2
Number of Municipalities Reporting	53	30	48	36
Population Represented (Millions)	7.6	4.3	6.6	4.6

Although these figures show an increasing dependence of the larger municipalities on user fees to support their costs of operation, there are more than 2000 systems in Canada serving about 20 million Canadians of which 67 percent serve a population less than 2500 persons. These smaller systems are generally heavily subsidized by the senior government in capital spending, and many rely on levies against property assessment to raise operating revenues.

In support of that statement, the Inquiry on Federal Water Policy (B-4) indicated in 1985 that the capital and operating costs of water supply and wastewater systems in Canada are generally covered by an amalgam of inter-governmental grants, tax revenues, fixed levies, and fees based on recorded use. It suggested that:

> Charges levied on users covered only 75% of recorded costs but because recorded costs normally excluded grants and amortization allowances, the proportion of true economic costs covered by user charges is much lower.

Research studies undertaken for the Inquiry recorded that the national municipal water withdrawal figures for 1984 were 4,263 million cubic meters and assuming a served population of 21,900,000 persons, the average gross per capita municipal use was 195 cubic metres per year or 535 litres per day.

In 1988, Environment Canada published results of a 1987 survey (B-5) on municipal water and sewer rates to which it gave wide circulation. It related the mean price for water per month on a family of three using 35,000 litres of water per month for all of Ontario to $17.39 and indicated that this price was inclusive of sewer service charges (see Exhibit B-2). This consumer charge represented an annual charge of $70 per capita for residential service and $97 for gross per capita service based on 195 cubic meters per year. Here it is assumed that there are three persons per residential service. (Also gross per capita use represents total municipal consumption including all uses divided by population served).

Information from Statistics Canada, recorded last in 1984, indicated Canadian municipalities spent $2,213 million annually on water purification, $1,248 million on supply, and $965 million on sewage collection and treatment in which the federal government contributed $30 million and the provinces $382 million. Based on 1984 costs, therefore, and assuming 21.9 million Canadians serviced through municipal water systems, the average gross per capita cost of service was $57 per year and for waste water collection and treatment using a serviced population of 19.3 million was $50 per year. Adjusting to 1987 prices based on consumer price indexes, these figures inflate to $67 and $59 respectively or $126 per capita for the real cost of providing the combined service.

EXHIBIT B-2 TOTAL PRICE ($) TO RESIDENTIAL WATER USERS FOR SELECTED VOLUMES OF WATER SUPPLIED

by province and population size group

Province	10 m³				35 m³			
			percentiles				percentiles	
	mean	median	10th	90th	mean	median	10th	90th
Newfoundland	7.97	7.08	5.50	12.00	7.97	7.08	5.50	12.00
Prince Edward Island	11.20	11.42	10.36	12.75	14.93	12.75	11.60	19.34
Nova Scotia	10.00	9.65	6.92	12.72	13.26	12.98	7.04	18.05
New Brunswick	14.87	15.00	5.83	21.72	17.75	17.00	5.83	35.28
Quebec	8.12	4.00	7.50	12.50	9.54	8.48	5.42	15.00
Ontario	11.49	9.13	4.80	20.90	17.39	15.35	7.91	30.00
Manitoba	11.76	10.71	6.53	21.38	31.91	30.39	20.44	38.25
Saskatchewan	12.59	10.92	3.43	18.75	26.26	28.84	10.33	37.59
Alberta	16.04	15.00	6.06	30.00	29.86	29.75	12.72	47.18
British Columbia	8.62	8.00	3.83	13.85	10.09	9.00	4.67	17.31
Territories	19.00	18.29	6.00	31.10	33.19	23.80	19.00	58.04
Population size group								
1000 - 4999	12.96	10.67	5.83	24.74	17.62	12.50	7.08	35.73
5000 - 9999	11.03	10.00	4.80	16.67	16.40	14.00	6.60	28.08
10000 - 49999	10.51	9.30	4.79	17.67	15.82	11.63	6.25	29.75
50000 - 99999	9.41	7.36	3.78	19.53	13.57	10.63	5.67	28.99
> 100000	8.34	7.30	3.70	13.74	15.91	15.40	5.00	28.99
Canada	10.90	9.25	4.80	19.53	18.06	12.71	6.60	30.00

EXHIBIT B-3 TOTAL PRICE ($) TO COMMERCIAL WATER USERS FOR SELECTED VOLUMES OF WATER SUPPLIED

by province and population size group

Province	10 m³				50 m³			
			percentiles				percentiles	
	mean	median	10th	90th	mean	median	10th	90th
Newfoundland	11.47	1.58	0.62	25.00	14.67	7.92	3.08	25.00
Prince Edward Island	18.20	17.76	17.76	19.52	29.95	29.20	29.20	32.20
Nova Scotia	19.15	16.65	8.13	27.53	23.30	21.07	14.80	30.73
New Brunswick	16.37	14.79	4.44	26.82	24.30	21.00	9.67	38.26
Quebec	8.94	7.08	1.70	17.67	13.51	11.75	5.85	23.12
Ontario	13.73	10.76	5.10	26.11	24.72	21.87	9.50	42.51
Manitoba	16.87	10.74	6.16	37.57	45.92	41.11	20.93	53.13
Saskatchewan	14.73	14.50	8.60	21.98	38.55	40.54	14.50	53.15
Alberta	21.01	20.12	12.71	32.75	45.54	44.12	20.12	65.18
British Columbia	10.31	9.18	4.00	17.30	13.49	11.69	5.67	26.00
Territories	13.30		6.80	19.80	30.25		26.50	34.00
Population size group								
1000 - 4999	15.34	11.81	5.10	31.49	24.17	18.50	8.00	51.90
5000 - 9999	13.60	12.24	7.17	24.33	22.83	19.17	6.50	41.78
10000 - 49999	11.43	9.85	4.60	19.25	21.43	17.83	7.92	42.51
50000 - 99999	12.76	8.75	2.97	28.68	20.51	15.88	7.92	35.00
> 100000	10.15	7.92	4.40	23.32	25.80	23.81	8.67	53.08
Canada	13.00	10.50	4.42	25.76	26.01	19.08	7.92	42.51

So a gross cost of $126 per capita per year compares with a consumer charge of $97 for gross per capita service, a differential in the combined service which represents a shortfall of 23 percent and suggests an even greater shortfall on a residential per capita basis.

Not all user charges for water and wastewater service relate directly to water demand. Some of the system cost is chargeable against property value because of its capacity for fire protection while both the water and sewage works provide capacity on a "readiness to serve" basis for properties yet to be developed. So subdivision contributions and redevelopment imposts based on system capacity are required to cover off these "readiness to serve" costs. The portion of system costs that should be charged to fire protection and "readiness to serve" is variable based on system size and the character of the service area.

The Ontario Section of the American Water Works Association undertakes a "Survey of Municipal Water Rates", the latest version of which covers the condition for 1987.
Where the Environment Canada Survey sampled 183 Ontario Municipalities, the AWWA Survey included 204. The latter concentrated its results in smaller systems with the former providing a broader approach (see Exhibit B-4). The AWWA survey disclosed that only 90% of user revenues came from water rates and the remainder from fire protection, impost and "readiness to serve" contributions. Water rate charges for the typical consumer based on residential as well as gross use were approximately equivalent to $80 and $124 per capita per year including surcharges for sewage where applicable. In that regard, the Ontario survey indicated that sewerage surcharges were averaging almost 100 percent of actual water charges. However, the relative charges disclosed by the AWWA survey and the national survey do support one another. A more recent study, Sewer Rates in Ontario (B-6), indicates from a statically questionable base that the median surcharge for sewer service was 92 percent of the water bill.

On a very broad analysis, it would appear that current direct charges for water and sewer services or user fees are established at about 75 percent of actual costs. Most systems, however, are not providing for an adequate rehabilitation and replacement program and it has been estimated that if that were occurring, the average system cost or an annual per capita basis would increase by $25 for the combined services. Current charges would then only reflect about 65% of actual costs.

EXHIBIT B - 4- 1987 WATER RATE SURVEY - ONTARIO SEC.AWWA
POPULATION GROUPING

	0-1000	1000-5000	5000-15000	15000-35000	OVER 35000
Municipalities Reporting	90	64	16	13	11
Approx. Population Served	107,600	490,600	453,065	1,081,000	4,142,000
Water Source	67% G.	50% G.	44% G.	15% G.	9% G.
Services metered-75% or more	27%	40%	62%	77%	91%
Percentage using Minimum Bill	11%	41%	69%	85%	82%
Minimum Charge	76-Rg.$3-$29	46-Rg.$3-$40	8-Rg.$5.55-$33	10-Rg.$1.62-$23	8-Rg.$7.00-$14
Median Per Month	$7.90	$12.11	$11.85	$5.44	$6.30
Typical Monthly Bill based on using					
-20 M3/Month	$15	$11	$21	$25	$15
-100 M3/Month	$45	$38	$42	$55	$46
-500 M3/Month	$178	$153	$162	$180	$178
-10,000 M3/Month	$3,673	$2,228	$2,359	$2,677	$3,265
Municipalities Employing Fire Protection Charges	25%	70%	69%	77%	55%
icipalities Employing Sewage Surcharges					
-P.- Number	50%	66%	56%	77%	55%
-% BF Water - % of Water Bill	30%	95%	84%	59%	100%
Revenue Source					
-Rates	95.5%	76.3%	89.6%	89.0%	89.5%
-Fire Protect.	1.5%	5.3%	5.6%	6.9%	4.5%
-Impost.	1.2%	10.1%	1.3%	0.5%	2.0%
-Miscellaneous	1.8%	8.3%	3.5%	3.6%	4.0%

A detailed comparison with several of the actual municipal water and sewage works appears warranted to confirm these figures in a general way. In 1989, the average charge to all consumers in Toronto for water and sewage services was 55 cents per 1000 litres. This figure represented not only the charge but the real cost, for the City has in place a full cost charging system and a comprehensive rehabilitation program. Using the residential figure of 140 cubic meters per capita per year, city charges and costs on a residential basis would represent $77 per year or on a gross overall basis $107. As a larger community and considering economies of scale this provides a good comparison with the foregoing national and provincial means.

Exhibit B-5 shows water and sewage service charges for a number of medium sized Ontario cities. The figures shown check well with the Ontario survey by AWWA and bear out the mean previously quoted.

In Ottawa-Carleton, the surcharge on the water bill for sewage service has recently been increased from 40 percent to 100 percent so that except for fire protection charges, the full cost of service is collected as a user fee based on 70 cents per cubic meter which is equivalent to $109 to $152 per capita per year. These figures are well above the mentioned cost figures but reflect the high cost of a major rehabilitation program that has been created by reason of leaving the system poorly maintained for too long.

B.3 SUBSIDIES

None of the foregoing surveys suggest that water charges are any less cheaper in larger than in smaller communities. Yet numerous studies have indicated that treatment costs for both water and sewage works service are at least three times more expensive per capita in a system servicing less than 1000 persons than one serving 65,000, and sewer and service costs are at least twice as expensive in small communities because of a lower population density per kilometre of main or sewer. Subsidies have a very significant impact therefore in covering off the cost differentials to equate actual rates for services in the small communities to those in larger systems.

EXHIBIT B-5

1987 TYPICAL WATER BILLING in Various Southerwestern Ontario Municipalities ($/yr.)

	RESIDENTIAL	COMMERCIAL & INDUSTRIAL		"FIRE PROTECTION" CHARGES	
	60,000 gal./yr.	600,000 gal./yr.	6,000,000 gal./yr.	% of Revenue	Background
Waterloo	94	780	7,740	2%	in Mill Rate, $60/Hydrant
Kitchener	108	973	8,752	0	
London	123	815	6,805	2%	in Mill Rate, Hydrant maintenance
Stratford	58	376	3,582	20%	in Mill Rate
Woodstock	67	507	4,341	5%	in Mill Rate, $75/Hydrant
Guelph	70	534	5,284	Not Charged Separately	
Ingersoll	114	981	7,162	10%;	1% to Industry; 9% on Mill Rate
Tillsonburg	148	1,042	10,004	13%	in Mill Rate
Chatham	126	1,155	8,918	Not Charged Separately	
Sarnia	112	787	7,794	3%	in Mill Rate
St. Thomas	150	942	8,674	12%	in Mill Rate

Here in Ontario, a myriad of provincial financial assistance programs exist to aid municipalities - more than 136 at last count.

Those that reflect directly on water and sewage works include:

1. Drainage Works (OMAF)

   Grants to cover one-third to two-thirds the capital costs of works assessed against agricultural lands within a municipality - **the Drainage Act**

2. Drainage Works Erosion Control Program (OMAF)

   Grants to cover 80 percent of the cost of materials to prevent erosion in municipal drains serving agricultural lands - **Order in Council**

3. Water and Sewage Works (MOE)

   a) Direct Grants Program (over 7500)

      A grant of up to 33 percent of the cost of works that support urban growth and are designed to resolve health and environmental problems.

   b) Direct Grants Program (Under 7500)

      In addition to grants for major works, funding assistance is also provided for local water distribution and sewage collection works. Grants are calculated on a sliding scale starting at 33% for 7500 population to 85% per 1000 or less.

c) Lifelines Program (MOE)

Grants are available for the completion of engineering "Needs Studies" for water distribution or sewage collection systems and for the physical rehabilitation of such facilities as determined from the "Needs Studies". Grant assistance for the studies is based on a municipal population with a minimum grant of 50 percent. Grant assistance for the physical rehabilitation work is provided at a level of 33-1/3 percent.

Also included in the "Lifelines" Program is a grant program relating to pollution control planning studies. Such plans are expected to outline the nature, cause and extent of pollution problems, propose alternate remedial measures, and recommend an implementation program. The minimum level of assistance for such studies is 50 percent.

4. Municipal Tax Assistance - Local Improvement Drainage Assessments, and Water, Sewage, and Garbage Rates (MMA)

Assistance is provided in respect to provincially owned properties within the municipality and their assessment of drainage costs and other special service charges. Assistance grants are calculated on the assessment procedure set out in the Drainage Act or the Local Improvement Act.

5. OTHER

a. **Operating Grants to Local Services Boards for Basic Services - Territory without Municipal Organization in Northern Ontario (MND)**

Up to 50 percent of the operating and maintenance costs for providing basic services in an unincorporated area which is managed by a Local Services Board for water supply, sewage disposal, etc.

Assistance is based on matching dollar for dollar with monies raised locally.

b. Union Corporated Communities Capital Assistance Program (UCCAP)

Provides Local Services Board and non-profit corporations in unincorporated communities with 50 percent of the costs up to $7500 for minor capital expenditures associated with the provision of basic services related to water supply, sewage etc.

c. Industrial Infrastructure (Northern Development Subsidies Program)

The program is designed to remove specific physical constraints to the development of identified small scale private sector projects. Assistance may include mapping, power, water supply, waste disposal, access, and other public services. Assistance to the municipalities will be in the form of grants, normally not exceeding 75 percent of approved capital costs or $200,000, whichever is less.

6. Roads, Bridges and Culverts (MOT)

Based on detailed municipal requirements, the Ministry provides 50 percent assistance for road and bridge construction and maintenance; up to 80 percent of the road and bridge construction and maintenance if the Minister regards the needs and financial capability of the municipality merit it. This program can include assistance in the building of storm sewers, up to 27 inch diameter, if provided in part for road drainage.

The foregoing direct assistance programs represent a significant capital contribution to the building and rehabilitating of municipal water and sewage works in Ontario. The current value of these direct programs in 1989, according to budgetary figures, will approach $100 million and do favour assistance to smaller systems, thus supporting the equalization of service rates despite system size.

The unconditional grants program administered by the Ministry of Municipal Affairs and relating to household grants and resource equalization payments provides significant overall municipal assistance (at least $30 per household per year) which is used by some municipalities to defray the cost of services.

B.4 OBSERVATIONS OF CURRENT COSTS AND RATES

Based on information revealed by the Federal current practice survey of 1988 and the 1987 Survey of the Ontario Sector of the American Water Works Association, and the 1989 PCAO/OSWCA Sewer Survey, a number of conclusions can be drawn on the relation of current costs for water and waste water management services to actual customer charges.

1. The concerns of the Inquiry on Federal Water Policy expressed earlier in this appendix were borne out.

2. Current direct charges for water and sewer services (user fees) are established at about 75% of costs. But this excludes proper provision for rehabilitation of infrastructure. An allowance for that exclusion would reduce charges to 65 percent of cost.

3. Rate setting follows no established patterns such as those recommended by the AWWA Water Rates Manual or the Sewer Charges recommended by the Water Pollution Control Federation.

4. Rate schedules vary widely among municipalities for that reason.

5. System costs vary widely depending on per capita use, wastage, leakage, treatment, living standard, weather, pressure, industrialization, extent of metering, and system management.

6. More than 50% of systems in Ontario serving populations less than 15,000 depend on ground water as a water source which minimizes supply costs.

7. In Ontario, most smaller systems do not meter the majority of customers but operate on flat rate. Overall, less than half the systems are fully metered and less than half the customers within the Province are metered.

8. Virtually all systems employ fire protection charges based on hydrant rental or a levy on property assessment. Many levy impost charges on new or redevelopment. In Ontario these sources of revenue represent about 10% of total income for water and waste water utilities.

9. The most common type of rate schedule is flat rate for unmetered systems or a descending block rate for metered systems.

10. Virtually all rate schedules therefore, either provide no incentive to conserve water or actually provide an increasing disincentive.

11. Most systems operating on a flat rate basis have an automatic minimum charge or bill while many metered systems employ a minimum charge plus a volumetric charge. The mean monthly charge varies from $3 to $40 with median of $8.75.

12. Most systems employ separate fire protection charges.

13. Most systems, 67 percent of all sizes, employ sewer surcharges which represent on average about 95 percent of water charge. However, the actual water charge is confused by this surcharge. It is difficult to determine at times whether the quoted water schedule includes sewer surcharge or not.

APPENDIX B - REFERENCES

B-1 "Water Crisis: Ending the Policy Drought". Terry Anderson - Journal of Fresh Water, Dec. 1983. Havarre, Minn.

B-2 "Pricing of Water". Amelia Armitage - Journal of Fresh Water Vol. 7, 1983. Havarre, Minn.

B-3 "Canada's Urban Infrastructure: Physical Condition and Funding Adequacy". Prepared for the Federation of Canadian Municipalities by the Technical Committee on Canada's Urban Infrastructure. June 1984.

B-4 "Currents of Change". Report of the Inquiry on Federal Water Policy, Environment Canada, September 1988.

B-5 "Water Demand Management in Canada: A State of the Art Review". D. W. Tate, Inland Waters Directorate, Environment Canada. Ottawa, 1988.

B-6 "Survey of Municipal Sewage Systems in Ontario". Pollution Control Association of Ontario and Ontario Sewer and Water Main Contractors Association. 1989.

B-7 "Fundamental Issues in the Development and Management of Small Water Supply Systems". J. W. MacLaren. Drinking Water Treatment Alternatives - Small System Alternatives: Proceeding of the Third National Conference on Drinking Water. St. John's, Nfld. June 12-14, 1988.

APPENDIX B - EXHIBITS

B-1 Source of Support Funds

B-2 Total Price ($) to Residential Water Users for Selected Volumes of Water Supplied

B-3 Total Price ($) to Commercial Water Users for Selected Volumes of Water Supplied

B-4 1987 Water Rate Survey - Ontario Section, AWWA

B-5 1987 Typical Water Billing

APPENDIX C

COST ALLOCATION AND RATE STRUCTURES

APPENDIX C

COST ALLOCATION AND RATE STRUCTURES

C.1 GENERAL

It was revealed in Appendix B that current charges for water and sewage works service in Ontario municipalities, based on established rate systems, generally fall short of providing sufficient funds from users to cover the real cost of service.

The Inquiry on Federal Water Policy revealed in its investigations reported in 1985 (C-2), a variety of deficiencies in the pricing systems employed in municipal water utilities in Canada that contradict the user pay principle, do not support conservation, and do not reflect the essence of a landmark report rendered by a Joint Committee of the American Society of Civil Engineers and the American Bar Association which stated:

> **The needed total revenues of (water and) wastewater systems shall be contributed by users and non-users (or users and properties) for whose use, need and benefit the facilities of the system are provided approximately in proportion to the cost of providing the use and benefit of the facilities. (C-2)**

With that in mind, the Inquiry on Federal Water Policy found in its investigations that:

- "Many users are unmetered and so are not assessed according to their demands on the systems.
- Some costs including depreciation and reserves for future expansion, are not accounted for in the rate base.
- Charges do not cover full costs (in frequent situations).
- The value of water itself is not recognized.
- The allocation of costs among fixed rates, minimum user fees and per unit prices is unsystematic.

- Declining block rates blunt incentives to conserve water and leave users paying marginal prices."

These points were borne out in the recent Federal rate survey referred to in Appendix B. These inequities are contrary to sound utility service, and establishment of fair and equitable practices among system customers.

They also fail to encourage conservation of the resource, and in many cases encourage its misuse. To counteract these conditions, a process of commercialization is necessary to introduce the concept of sustainable resource use.

> **Commercialization of these services is a process of change which aims to subject government activities in appropriate ways to discipline and measurement by forces of the market. (C-3)**

Such a procedure can be termed **revenue dependency** or **full cost pricing**. The utility continues to operate "in-house" but the municipality determines to departmentalize it through appropriate accounting and legal procedures to disclose the full cost of providing the service. It is necessary to separate it's costs from the municipality's general account and to enter into enterprise fund accounting. This term has been defined by the U.S. National Council of General Accounting (C-4) as to "account for operations that are financed and operated in a manner similar to private business enterprises where the intent of the governing body is that the costs (expenses including depreciation) of providing goods and services to the general public on a continuous basis be financed or recovered primarily through user charges."

By disclosing the total cost of providing water, an enterprise accounting system identifies the necessary financial information to determine the full cost of service and the extent to which revenue generated from rates covers that cost. It is then possible to properly allocate these costs based on system function and consumption type so as to establish a fair and equitable set of water or sewerage rates. Charges based on these rates can then be directed to raising the needed revenues to cover the total cost of providing the water services and waste water, including system rehabilitation and expansion.

Such a procedure responds to the landmark report previously quoted and when supported by universal metering, permits utility operation to be established on a full beneficiary-pay basis so that the operation is revenue dependent, fair and equitable among users, and oriented to the conservation of the resource. Revenue dependency is therefore by definition a fully comprehensive approach to fiscal as well as resource management. In addition, it maintains the environmental objectives of sustainable development by ensuring that users are aware through direct charges of the impact of their needs.

As Postel stated in 1985

> **Only by managing water demand rather than ceaselessly striving to meet it is there hope for a truly secure and sustainable water future.**

C.2 COST ALLOCATION

In determining the allocation of capital and operating costs among municipal customers for water and wastewater service, it is important to recognize the variables in system and consumer demand.

Per capita demands for water depend on a number of parameters including climate, standard of living, extent of sewerage service, extent of industrialization and commercialization, cost of water, physical, chemical and biological quality of water, system pressure, extent of metering, and system condition and management.

One significant variable in calculating water consumption has been the amount of unaccounted-for-water which represents water for firefighting, sewer and street flushing, lawn watering of public grounds, construction site water, hydrant flushing and most significantly, water main leakage.

Similarly waste water flows although reduced by unaccounted-for-water, are usually equal or more than water consumption due to infiltration from ground water through loose sewer joints and pipewall cracks and from direct extraneous flows.

The rate of water demand changes with the seasons, the days of the week, and the hours of the day. Generally, the maximum day of demand exceeds the average by 1.5 to 2.0 times while the maximum exceeds the average hour by 2 to 3 times. Firefighting flows impose another peak on waterworks systems that relate to density and land-use. Municipal water demand by user classes for Canada is set out in Exhibit C-1.

Peak flows in waste water systems fluctuate more modestly due to the delay effect caused by gravity flow in collecting sewers and the dampening effect of continuous infiltration. On that basis, the maximum daily flow rarely exceeds 1.5 times the annual average day with the peak hour representing about 1.5 times the 24 hour flow.

Individual consumers create broad variations in intensity and time of system use and introduce many forms of inefficient demand for water supply thereby creating unnecessary sewage flows. Health and Welfare Canada estimated in 1978 that although the average gross per capita demand for water from municipal systems was 500 litres per day, per capita consumption of tap water was only 1.34 litres per day.

Most water utilities still base their charging policies for public water supply and sewage works service on financial and political considerations rather than economic. Financial requirements were and are currently the foundation of rate setting practices. The philosophy predominant in the industry is that the total annual cost of providing water service is equal to the annual revenue requirement applicable to the particular utility. Since the needs for total volume of supply and peak demands vary among consumers, the costs to the utility of providing service vary among customers or their classes.

Accordingly, the American Water Works Association (C-5) advocates that "a sound analysis of the adequacy of charges requires allocation of costs among customers commensurate with their service requirements in order to recognize differences in costs of furnishing services to different types of customers."

The total costs of service are generally considered under two major categories - **operation and maintenance costs** and **capital costs.** These costs are usually recorded under system function such as supply, pumping, treatment, transmission and distribution, customer service, and management.

EXHIBIT C-1

MUNICIPAL WATER SUPPLY BY USER CLASS

Source: 1976 - Tate and Lacelle, 1978
1981 - National Inventory, 1981

Province	Percentage Allocation of Pumpage (%) Domestic	Commercial/Institutional	Industrial	Losses	Unaccounted	Per Capita Use (l day^{-1}) Domestic	Industrial[a]
1976							
Newfoundland	71	9	20	0	1	482	135
Prince Edward Island	47	38	10	5	0	246	52
Nova Scotia	31	15	39	15	0	214	269
New Brunswick	56	17	25	3	0	296	355
Quebec	49	13	18	7	13	391	143
Ontario	38	19	23	10	10	278	167
Manitoba	47	21	12	18	1	205	52
Saskatchewan	38	22	16	16	8	168	71
Alberta	39	33	22	1	4	268	151
British Columbia	44	16	15	1	24	405	138
Territories	52	27	2	1	18	569	22
Canada	44	17	20	8	11	332	151
1981							
Canada	51	11 4	19	15		n.a.	n.a.

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[a] Estimated in a similar manner to domestic per capita consumption with a portion of unaccounted consumption allocated to this use category.

Source: The Economics of Municipal Water Supply: Applying the User-Pay Principle, June 1985

Operating costs are broken down into salaries, materials and supplies, power, chemicals, etc. while capital costs are amortized and related to plant investment with respect to system function and include principal and interest on debt, depreciation or annual requirements for replacements, extensions and improvements and payments in lieu of taxes. Capital costs are generally reduced by the value of conditional assistance grants from senior governments and special capital contributions.

In North America, the purpose of cost allocation is therefore to express the cost of service in terms of costs associated with supplying both the customers' average and peak rates of use or demand, costs related to customers meters, services and accounts, and direct costs to provide fire protection. These costs by function are further distributed to customers classes on the basis of their particular requirement for a specific service.

Three systems of allocations are still in vogue.

1. Base Extra Capacity - in which costs are separated into four primary components (a) base costs, (b) extra capacity costs, (c) customers costs and (d) direct fire protection costs. Base costs include all costs related to service under average load conditions. Extra capacity costs are associated with costs of providing capacity beyond that required by average use. Customer costs comprise costs associated with serving customers irrespective of water use while direct fire protection includes costs relating only to fire fighting such as hydrants, main oversizing and incremental storage. Exhibits C-2, C-3 and C-4 demonstrate the allocation of costs according to system function using the Base-Extra Capacity Method.

2. Commodity-Demand Method - separates the costs of service into four primary components (a) commodity costs, (b) demand costs, (c) customer costs and (d) direct fire protection costs. Commodity costs are costs that tend to vary with the quantity of water produced such as chemicals. Demand costs are associated with providing facilities to meet the peak rates of use or demands placed on the system by the customers. They include capital-related costs on plant, designed to meet peak requirements plus associated operating and maintenance costs.

EXHIBIT C-2

Allocation of Plant Value
Base-Extra Capacity Method
Test Year

			Extra Capacity			
Item	Total $	Base $	Maximum Day $	Maximum Hour $	Customer Meters & Services $	Direct Fire Service $
Source-of-supply plant:						
Land and land rights	423,000	423,000				
Reservoir	204,000	204,000				
Pumping plant:						
Raw water pumping and transmission lines	114,000	74,000	40,000			
Treated-water pumping	425,000	276,000	149,000			
Treatment plant	1,048,000	681,000	367,000			
Transmission and distribution plant:						
Structures and improvements	40,000	13,000		17,000	9,000	1,000
Distribution storage	413,000	41,000		372,000		
Transmission mains	3,112,000	1,400,000		1,712,000		
Distribution mains	1,830,000	824,000		1,006,000		
Meters	472,000				472,000	
Services	1,078,000				1,078,000	
Fire hydrants	248,000					248,000
General plant:						
Office	186,000	78,000	11,000	61,000	31,000	5,000
Vehicles	17,000	7,000	1,000	6,000	3,000	
Other	141,000	59,000	8,000	47,000	23,000	4,000
Total plant value	9,751,000	4,080,000	576,000	3,221,000	1,616,000	258,000
Less: Contributions in aid of construction	750,000				750,000	
Rate base	9,001,000	4,080,000	576,000	3,221,000	866,000	258,000

Source: **Water Rates, American Water Works Association, 1983.**

EXHIBIT C-3

Allocation of Depreciation Expense
Base-Extra Capacity Method
Test Year

			Extra Capacity			
Item	Total $	Base $	Maximum Day $	Maximum Hour $	Customer Meters & Services $	Direct Fire Service $
Source-of-supply plant:						
Land and land rights						
Reservoir	3,200	3,200				
Pumping plant:						
Raw water pumping and transmission lines	3,500	2,300	1,200			
Treated water pumping	14,200	9,200	5,000			
Treatment plant	28,000	18,200	9,800			
Transmission and distribution plant:						
Structures and improvements	1,100	200		400	400	100
Distribution storage	10,300	1,000		9,300		
Transmission mains	37,500	16,900		20,600		
Distribution mains	32,500	14,600		17,900		
Meters	22,500				22,500	
Services	33,200				33,200	
Fire hydrants	8,300					8,300
General plant:						
Office	4,600	1,600	400	1,100	1,300	200
Vehicles	4,000	1,400	300	1,000	1,100	200
Other	10,100	3,400	800	2,500	3,000	400
Total depreciation expense	213,000	72,000	17,500	52,800	61,500	9,200

Source: **Water Rates, American Water Works Association, 1983.**

EXHIBIT C-4

Allocation of Operation-and-Maintenance Expense
Base-Extra Capacity Method
Test Year

			Extra Capacity		Customer Costs		
Item	Total $	Base $	Maximum Day $	Maximum Hour $	Meters & Services $	Billing & Collecting $	Direct Fire Service $
Source of supply	17,000	17,000					
Pumping:							
Power	152,700	137,400	15,300				
Other	107,400	69,800	37,600				
Total	260,100	207,200	52,900				
Treatment:							
Chemicals	99,900	99,900					
Other	69,600	45,200	24,400				
Total	169,500	145,100	24,400				
Transmission and distribution:							
Distribution storage	14,000	1,400		12,600			
Transmission mains	54,100	24,300		29,800			
Distribution mains	35,200	15,800		19,400			
Meters	96,600				96,600		
Services	35,300				35,300		
Fire hydrants	16,500						16,500
Other	60,000	9,900		14,700	31,500		3,900
Total	311,700	51,400		76,500	163,400		20,400
Customer billing and collecting:							
Meter reading	110,800					110,800	
Billing and collecting	203,700					203,700	
Other	11,800					11,800	
Total	326,300					326,300	
Administration and general:							
Fringe benefits	81,800	24,400	8,700	7,400	16,000	22,600	2,700
Other	303,600	69,000	23,500	27,900	59,600	115,900	7,700
Total	385,400	93,400	32,200	35,300	75,600	138,500	10,400
Total operation-and-maintenance expense	1,470,000	514,100	109,500	111,800	239,000	464,800	30,800

Source: **Water Rates, American Water Works Association, 1983.**

Customer costs and direct fire protection costs are defined as for base-extra capacity. Exhibits C-5, C-6 and C-7 show the allocation of costs for the Commodity-Demand Method which can be compared on a same example basis with Exhibit C-2, C-3 and C-4. The comparison shows how the commodity-demand system places much greater cost responsibility on demand than the base- extra capacity method.

3. Functional-Cost Method - separates all costs into four functions which describe the operation of the utility i.e. production and transmission, distribution, customer costs, and hydrants and connections. It is an older system that has had little recognition in recent years since it fails to recognize significant costs related to capacity or demand service.

C.3 COST ALLOCATION TO CUSTOMER CLASSES

Before water rates can be set according to the base-capacity or the commodity-demand methods some effort must be made to distribute component costs to customer classes. Obviously, it is not possible to specifically design cost responsibility to each individual customer. But costs can be assigned to groups or classes of customers having similar water-using characteristics so as to prevent ultimate rates from being discriminating and inequitable.

Customer classes are determined according to service characteristics, demand patterns, and volume requirements. The four principal customer classes typical of most water utilities are:

residential	-one or two family dwellings
commercial	-multi-unit apartment buildings, row housing, stores, office buildings, plazas, etc. -generally include warehousing areas
industrial	-manufacturing and processing establishments

EXHIBIT C-5

Allocation of Plant Value
Commodity-Demand Method
Test Year

			Demand			
Item	Total $	Commodity $	Maximum Day $	Maximum Hour $	Customer Meters & Services $	Direct Fire-Protection Service $
Source-of-supply plant:						
Land and land rights	423,000	423,000				
Reservoir	204,000	204,000				
Pumping plant:						
Raw water pumping and transmission lines	114,000		114,000			
Treated water pumping	425,000		425,000			
Treatment plant	1,048,000		1,048,000			
Transmission and distribution plant:						
Structures and improvements	40,000			30,000	9,000	1,000
Distribution storage	413,000			413,000		
Transmission mains	3,112,000			3,112,000		
Distribution mains	1,830,000			1,830,000		
Meters	472,000				472,000	
Services	1,078,000				1,078,000	
Fire Hydrants	248,000					248,000
General plant:						
Office	186,000	12,000	31,000	107,000	31,000	5,000
Vehicles	17,000	1,000	3,000	10,000	3,000	
Other	141,000	9,000	24,000	81,000	23,000	4,000
Total plant value	9,751,000	649,000	1,645,000	5,583,000	1,616,000	258,000
Less: Contributions in aid of construction	750,000				750,000	
Rate base	9,001,000	649,000	1,645,000	5,583,000	866,000	258,000

Source: Water Rates, American Water Works Association, 1983.

EXHIBIT C-6

Allocation of Depreciation Expense
Commodity-Demand Method
Test Year

			Demand			
Item	Total $	Commodity $	Maximum Day $	Maximum Hour $	Customer Meters & Services $	Direct Fire-Protection Service $
Source-of-supply plant:						
Land and land rights						
Reservoir	3,200	3,200				
Pumping plant:						
Raw water pumping and transmission lines	3,500		3,500			
Treated water pumping	14,200		14,200			
Treatment plant	28,000		28,000			
Transmission and distribution plant:						
Structures and improvements	1,100			600	400	100
Distribution storage	10,300			10,300		
Transmission mains	37,500			37,500		
Distribution mains	32,500			32,500		
Meters	22,500				22,500	
Services	33,200				33,200	
Fire Hydrants	8,300					8,300
General plant:						
Office	4,600	100	1,100	1,900	1,300	200
Vehicles	4,000	100	900	1,600	1,200	200
Other	10,100	200	2,400	4,200	2,900	400
Total depreciation expense	213,000	3,600	50,100	88,600	61,500	9,200

Source: Water Rates, American Water Works Association, 1983.

EXHIBIT C-7

Allocation of Operation-and-Maintenance Expense
Commodity-Demand Method
Test Year

			Demand		Customer Costs		
Item	Total $	Commodity $	Maximum Day $	Maximum Hour $	Meters & Services $	Billing & Collecting $	Direct Fire-Protection Service $
Source of supply	17,000	17,000					
Pumping:							
Power	152,700	108,400	44,300				
Other	107,400		107,400				
Total	260,100	108,400	151,700				
Treatment:							
Chemicals	99,900	99,900					
Other	69,600		69,600				
Total	169,500	99,900	69,600				
Transmission and distribution:							
Distribution storage	14,000			14,000			
Transmission mains	54,100			54,100			
Distribution mains	35,200			35,200			
Meters	96,600				96,600		
Services	35,300				35,300		
Fire hydrants	16,500						16,500
Other	60,000			24,600	31,500		3,900
Total	311,700			127,900	163,400		20,400
Customer billing and collecting:							
Meter reading	110,800					110,800	
Billing and collecting	203,700					203,700	
Other	11,800					11,800	
Total	326,300					326,300	
Administration and general:							
Fringe benefits	81,800	2,300	25,000	13,200	16,000	22,600	2,700
Other	303,600	6,400	67,100	46,900	59,600	115,900	7,700
Total	385,400	8,700	92,100	60,100	75,600	138,500	10,400
Total operation-and-maintenance expense	1,470,000	234,000	313,400	188,000	239,000	464,800	30,800

Source: **Water Rates, American Water Works Association, 1983.**

public authority	-government buildings, schools, churches, etc.

Certain special customers can exist that include high demand service (wholesale), special fire protection service, etc.

As a step toward rate design, components costs can be distributed among customer classes according to the relative responsibility that each class bears to the cost of the total system. Responsibility for each component can be expressed in terms of the number of units service required by each class of customer.

The total cost of each component, such as base cost, may be divided by appropriate total customer requirements or units of service to express a unit cost for each component. These unit costs for each component serve as the basis for designing rates.

These costs are established by actual water use in a selected or test year so that units of service and costs can be derived for the same base. The unit cost provides an average cost of service, but a capacity factor based on peak demand to reflect maximum use rate for the class is necessary to indicate surplus capacity requirements.

As examples Exhibits C-8, C-9, C-10 & C-11 provide information on units of service and units of costs of service based on data provided in the previous sub-section for the base-extra capacity and commodity-demand programs. Cost distribution to customer classes can then directly be applied as set out in Exhibits C-12 and C-13.

C.4 IDENTIFICATION OF REVENUE REQUIREMENTS

The foregoing cost allocations according to service and customers provide the basis for establishing required revenues which normally should equal costs, so that the development of a schedule of rates can be based on recovering as nearly as possible the allocated costs of service by customer.

The foregoing tables reveal that there are basically two approaches used in North America for setting revenue requirements.

EXHIBIT C-8

Units of Service
Base-Extra Capacity Method
Test Year

	Base		Maximum-Day			Maximum-Hour				
Customer Class	Annual Use *thou. gal*	Average Rate *thou. gpd*	Capacity Factor %	Total Capacity *thou. gpd*	Extra Capacity *thou. gpd*	Capacity Factor %	Total Capacity *thou. gpd*	Extra Capacity *thou. gpd*	Equivalent Meters and Services	Bills
Inside-city:										
Retail service										
Residential	928,000	2,542	250	6,355	3,813	400	10,168	7,626	16,019	190,452
Commercial	590,000	1,616	200	3,232	1,616	325	5,252	3,636	1,951	12,528
Industrial	1,149,000	3,148	150	4,722	1,574	200	6,296	3,148	169	120
Fire-protection service				960	960		5,760	5,760		
Total inside-city	2,667,000	7,306		15,269	7,963		27,476	20,170	18,139	203,100
Outside-city:										
Wholesale service	210,000	575	225	1,294	719	375	2,156	1,581	20	36
Total system	2,877,000	7,881		16,563	8,682		29,632	21,751	18,159	203,136

Source: **Water Rates, American Water Works Association, 1983.**

EXHIBIT C-9

Unit Costs of Service
Base-Extra Capacity Method
Test Year

Item	Total Cost	Base	Extra Capacity		Customer Costs		Direct Fire-Protection Service
			Maximum Day	Maximum Hour	Meters & Services	Billing & Collecting	
Total system units of service:							
Number		2,877,000	8,682	21,751	18,159	203,136	
Units		thou. gal	thou. gpd	thou. gpd	equiv. meters	bills	
Operation-and-maintenance expense:							
Total	$1,470,000	$ 514,000	$109,500	$ 111,800	$239,000	$464,800	$ 30,800
Unit cost ($/unit)		0.1787	12.6123	5.1400	13.1615	2.2881	
Depreciation expense:							
Total	$ 213,000	$ 72,000	$ 17,500	$ 52,800	$ 61,500		$ 9,200
Unit cost ($/unit)		0.0250	2.0157	2.4275	3.3868		
Rate base:							
Total rate base	$9,001,000	$4,080,000	$576,000	$3,221,000	$866,000		$258,000
Unit rate base ($/unit)		1.4181	66.3442	148.0851	47.6899		
Payment in lieu of taxes:							
Total	$ 175,000	$ 79,300	$ 11,200	$ 62,700	$ 16,800		$ 5,000
Unit cost ($/unit)		0.0276	1.2900	2.8826	0.9252		
Unit return on rate base:							
Inside-city ($/Unit)[*]		0.0671	3.1381	7.0044	2.2557		$ 12,000
Outside-city ($/unit)[†]		0.1064	4.9758	11.1064	3.5767		
Total unit costs of service:							
Inside-city ($/unit)		0.2984	19.0561	17.4545	19.7292	2.2881	
Outside-city ($/unit)		0.3377	20.8938	21.5565	21.0502	2.2881	

[*] At 4.73 percent return on $8,420,000 rate base.
[†] At 7.5 percent return on $581,000 rate base.

Source: Water Rates, American Water Works Association, 1983.

EXHIBIT C-10

Units of Service
Commodity-Demand Method
Test Year

Customer Class	Commodity		Maximum-Day		Maximum-Hour		Equivalent Meters and Services	Bills
	Annual Use *thou. gal.*	Average Daily Rate *thou. gpd*	Capacity Factor %	Total Capacity *thou. gpd*	Capacity Factor %	Total Capacity *thou. gpd*		
Inside-city:								
Retail service								
Residential	928,000	2,542	250	6,355	400	10,168	16,019	190,452
Commercial	590,000	1,616	200	3,232	325	5,252	1,951	12,528
Industrial	1,149,000	3,148	150	4,722	200	6,296	169	120
Fire protection service				960		5,760		
Total inside-city	2,667,000	7,306		15,269		27,476	18,139	203,100
Outside-city:								
Wholesale service	210,000	575	225	1,294	375	2,156	20	36
Total system	2,877,000	7,881		16,563		29,632	18,159	203,136

Source: Water Rates, American Water Works Association, 1983.

EXHIBIT C-11

Unit Costs of Service
Commodity-Demand Method
Test Year

Item	Total Cost	Commodity	Demand		Customer Costs		Direct Fire-Protection Service
			Maximum Day	Maximum Hour	Meters & Services	Billing & Collecting	
Total system units of service:							
Number		2,877,000	16,563	29,632	18,159	203,136	
Units		thou. gal	thou. gpd	thou. gpd	equiv. meters	bills	
Operation-and-maintenance expense:							
Total	$1,470,000	$ 234,000	$ 313,400	$ 188,000	$239,000	$464,800	$ 30,800
Unit cost ($/unit)		0.0813	18.9217	6.3445	13.1615	2.2881	
Depreciation expense:							
Total	$ 213,000	$ 3,600	$ 50,100	$ 88,600	$ 61,500		$ 9,200
Unit cost ($/unit)		0.0013	3.0248	2.9900	3.3868		
Rate base:							
Total rate base	$9,001,000	$ 649,000	$1,645,000	$5,583,000	$866,000		$258,000
Unit rate base ($/unit)		0.2256	99.3178	188.4112	47.6899		
Payment in lieu of taxes:							
Total	$ 175,000	$ 12,600	$ 32,000	$ 108,600	$ 16,800		$ 5,000
Unit cost ($/unit)		0.0044	1.9320	3.6650	0.9252		
Unit return on rate base:							
Inside-city ($/Unit)*		0.0107	4.6977	8.9118	2.2557		$ 12,000
Outside-city ($/unit)†		0.0169	7.4488	14.1308	3.5767		
Total unit costs of service:							
Inside-city ($/unit)		0.0977	28.5762	21.9113	19.7292	2.2881	
Outside-city ($/unit)		0.1039	31.3273	27.1303	21.0502	2.2881	

*At 4.73 percent return on $8,420,000 rate base.
†At 7.5 percent return on $583,000 rate base.

Source: **Water Rates, American Water Works Association, 1983.**

EXHIBIT C-12

Cost Distribution to Customer Classes
Base-Extra Capacity Method
Test Year

		Extra Capacity		Customer Costs			
Item	Base	Maximum Day	Maximum Hour	Meters & Services	Billing & Collecting	Direct Fire-Protection Service	Total Cost of Service
Inside-city:							
Unit costs of service ($/unit)	0.2984 per thou. gal	19.0561 per thou. gpd	17.4545 per thou. gpd	19.7292 per equiv. meter	2.2881 per bill		
Retail service:							
Residential:							
Units of service	928,000	3,813	7,626	16,019	190.452		
Allocated cost of service	$ 276,900	$ 72,700	$133,100	$ 316,100	$435,800		$1,234,600
Commercial:							
Units of service	590,000	1,616	3.636	1.951	12.528		
Allocated cost of service	$ 176,100	$ 30,800	$ 63,500	$ 38,500	$ 28,700		$ 337,600
Industrial:							
Units of service	1,149,000	1,574	3,148	169	120		
Allocated cost of service	$ 342,900	$ 30,000	$ 54,900	$ 3,300	$ 300		$ 431,400
Fire-protection service:							
Units of service		960	5,760				
Allocated cost of service		$ 18,300	$100,600			$57,000	$ 175,900
Total inside-city allocated cost of service							$2,179,500
Outside-city:							
Unit costs of service ($/unit)	0.3377	20.8938	21.5565	21.0502	2.2881		
Wholesale:							
Units of service	210,000	719	1,581	20	36		
Allocated cost of service	$ 70,900	$ 15,000	$ 34,100	$ 400	$ 100		$ 120,500
Total system allocated cost of service	$ 866,800	$166,800	$386,200	$358,300	$464,900	$57,000	$2,300,000

Source: Water Rates, American Water Works Association, 1983.

EXHIBIT C-13

Cost Distribution to Customer Classes
Commodity-Demand Method
Test Year

		Demand		Customer Costs			
Item	Commodity	Maximum Day	Maximum Hour	Meters & Services	Billing & Collecting	Direct Fire-Protection Service	Total Cost of Service
Inside-city:							
Unit costs of service ($/unit)	0.0977 per thou. gal	28.5762 per thou. gpd	21.9113 per thou. gpd	19.7292 per equiv. meter	2.2881 per bill		
Retail service:							
Residential:							
Units of service	928,000	6,355	10,168	16,019	190,452		
Allocated cost of service	$ 90,700	$181,600	$222,800	$316,100	$435,800		$1,247,000
Commercial:							
Units of service	590,000	3,232	5,252	1,951	12,528		
Allocated cost of service	$ 57,600	$ 92,400	$115,100	$ 38,500	$ 28,700		$ 332,300
Industrial:							
Units of service	1,149,000	4,722	6,296	169	120		
Allocated cost of service	$ 112,300	$134,900	$138,000	$ 3,300	$ 300		$ 388,800
Fire-protection service:							
Units of service		960	5,760				
Allocated cost of service		$ 27,400	$126,200			$57,000	$ 210,600
Total inside-city allocated cost of service							$2,178,700
Outside-city:							
Unit costs of service ($/unit)	0.1039	31.3273	27.1303	21.0502	2.2881		
Wholesale:							
Units of service	210,000	1,294	2,156	20	36		
Allocated cost of service	$ 21,800	$ 40,500	$ 58,500	$ 400	$ 100		$ 121,300
Total system allocated cost of service	$ 282,400	$476,800	$660,600	$358,300	$464,900	$57,000	$2,300,000

Source: Water Rates, American Water Works Association, 1983.

1. Utility Approach

The utility approach is followed in the U.S. by utilities regulated by state public service agencies and in Canada by privately held gas companies regulated by the Ontario and National Energy Boards. It allows the utility to recover operating and maintenance costs as determined by generally accepted accounting principles. In addition, the utility is permitted to earn a return on its capital investment as well as charge for depreciation on these assets and interest on its capital debt. Exhibits C-2, C-3, C-5 & C-6 reveals the rate base and depreciation expense as an example. The major advantage of this approach is that it requires the identification of less detail in justifying revenue requirements. The major disadvantage, however, is that the actual revenues generated in a particular year could be significantly different than actual requirement.

2. Cash-Need Approach

Under the cash-needs approach, user charges are structured to recover specific cash requirements for fixed costs (capital) as well as costs of operation and maintenance according to the cash budget requirements. The major difference from the utility approach is the manner in which capital costs are included. In the utility approach, depreciation, interest on debt and return on rate base provide the basis for capital requirements.

Under the cash-needs approach, specific capital requirements are set out including debt service (principal and interest), capital outlay (pay as you go capital) as well as contributions to various reserve funds. On that basis, the latter approach provides improved flexibility by identifying actual cash requirements for the utility. As a result the latter system is preferred by publicly owned utilities in North America and certainly here in Ontario.

Exhibit C-14 clearly demonstrates the definition of revenue requirements between the two approaches.

EXHIBIT C-14

IDENTIFICATION OF REVENUE REQUIREMENTS

Revenue Requirements Under Cash-Needs and Utility Approaches

Revenue Requirements Item	Cash-Needs	Utility
Operating Costs	$10,000,000	$10,000,000
Depreciation[a]		2,000,000
Return on Investment[b]		6,000,000
Debt Service[c]		
• Principal	4,000,000	
• Interest	7,000,000	7,000,000
Minor Capital Outlay	1,500,000	
Reserve Fund Contribution		
• Operating	500,000	
• Replacement	1,000,000	
• Expansion	1,000,000	
• Insurance	500,000	
• Rate Stabilization	500,000	
• Debt Service	1,000,000	
Total	$27,000,000	$25,000,000

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[a] On an investment of $100,000,000 (acquisition amount), with no contributions-in-aid-of-construction, and using a 2% composite depreciation rate.

[b] Rate of return is established at 6% (weighted cost of debt).

[c] Assumes $100,000,000 was bonded at 10% interest and amortized over 25 years with principal of $4,000,000 and interest of $7,000,000 during the rate recovery projection period.

Source: Water and Wastewater Finance and Pricing, 1989.

C.5 CURRENT RATE SETTING

To maintain equitability in water pricing, rates are designed as previously indicated to fit average conditions for a group of customers having similar service requirements. It should be noted here that without universal customer metering, equity and fairness within a group of customers is in jeopardy.

For reasons of practicality of application, administration and customer acceptance, it is common practice to provide water service to each customer class save exceptional large consumers through a single rate schedule comprised of a two part rate. It includes an initial charge to generally recover customer and possibly some volume of related costs, together with a volume-related charge to recover the costs of supplying the actual quantity of water consumed.

Customer costs set out in previous exhibits relate to costs incurred independent of any water used. They therefore cover metering, billing, collecting and managing the system plus a share of those costs that will be incurred whether water is used or not such as capital cost. A consumer may leave his residence for three months and use no water but the "readiness to serve" capability of the system stands prepared to supply him whenever he returns. The initial charge or minimum bill or service charge, whatever it may be called, frequently includes the cost of supply of a minimum quantity of water to recover some part of volume and extra capacity costs as well as these customer service costs.

An important issue with respect to the volume related charge in the two-part schedule is whether it will consist of a single rate per unit volume, irrespective of total volume of use or two or more rate blocks. Because of load factor effects, the rates for subsequent blocks generally decline for larger volumes of use and so the volume related system is referred to generally as a declining block schedule. This system does maintain equitability among customer classes but is contrary to water conservation principles since its cheapening unit prices encourage over-use and wastage.

Fire protection charges relate to property value and not water-use and should be collected as a direct levy against rateable property values.

Exhibits C-15, C-16 & C-17 provide evidence of the design of MONTHLY SERVICE CHARGES, TYPICAL COST OF WATER and APPLICATION OF PROPOSED RATES using examples previously described.

In the case of utilities serving unmetered customers, a system of flat rates is generally employed. These rates are usually based on estimated average use that can be related to the cost allocation procedure previously set out. They are applied to certain measures of customer service such as numbers of rooms, number of plumbing fixtures, size of lawn areas, etc. and even property value. Unfortunately, these rates encourage wastage rather than conservation and result in unfair and inequitable practices among customers.

Surveys referred to in Appendix B on water charges in Canada and municipal water practices, confirm the Inquiry's observations that relatively few are technically designed and less than 40 percent of the systems have more than 75 percent of customers metered. Usually only the major users are metered.

Those utilities that meter their customers use a variety of rate schedules that include a minimum bill plus a single volume rate or multi-block declining rate. Some include the cost of fire protection within the rate schedule while others charge directly for the service against property assessment.

Only a few of the systems recover the full cost of service in water rate schedules and most do not provide for system depreciation and the cost of rehabilitation. Indeed the Ontario Municipal Board does not favour charging for depreciation on an asset that still carries debt. The system of accounting used by most municipalities for water and sewer operations does not report the value of fixed assets on current replacement value depreciated for actual age.

Fixed assets are reported as expenditures in the year of acquisition, or if financed by long-term indebtedness, the principal and interest are reported as expenditures are incurred. Unfortunately, the use of this method of accounting is prescribed by the Ministry of Municipal Affairs in the Municipal Financial Reporting Handbook which is issued under the authority of Part II, Section 3 of the Municipal Affairs Act. Depreciation allowances are not encouraged.

EXHIBIT C-15

WATER RATES

Design of Inside-City Monthly Service Charges for ⅝-In. and 2-In. Meters
Test Year

Line No.		(1) Unit Cost	(2) Equivalent Meter and Service Ratio	(3) Cost $
	⅝-In. service charge:			
1	Meters and service related costs	$1.6441 per meter*	1.0†	1.64
2	Billing and collecting related costs	$2.2881 per bill		2.29
3	Total			3.93
4	Total (rounded)			3.95
	2-In. service charge:			
5	Meters and service related costs	$1.6441 per meter*	2.9†	4.77
6	Billing and collecting related costs	$2.2881 per bill		2.29
7	Total			7.06
8	Total (rounded)			7.05

*$19.7292 annually per equivalent meter ÷ 12 bills per year = $1.6441 per month per equivalent meter per Table 11, Section 3 of this manual.

†Ratio of investment in this size meter and related service relative to investment in a ⅝-in. meter and related service per Section 3 of this manual.

Source: **Water Rates, American Water Works Association, 1983.**

EXHIBIT C-16

Derivation of Typical Inside-City Cost per Thousand Gallons by Water-Use Blocks
Test Year

Line No.	(1) Water Use Block *thou. gal/month*	(2) Base Cost *$/thou. gal*	(3) Maximum Day: Extra Capacity Factor in Excess of Average Day %	(4) Maximum Day: Extra Capacity Cost[*] *$/thou. gal*	(5) Maximum Hour: Extra Capacity Factor in Excess of Average Day %	(6) Maximum Hour: Extra Capacity Cost[†] *$/thou. gal*	(7) Total Cost[‡] *$/thou. gal*
1	First 15	0.2984	150	0.0783	300	0.1434	0.5201
2	Next 1485	0.2984	100	0.0522	225	0.1076	0.4582
3	Over 1500	0.2984	50	0.0261	100	0.0478	0.3723

[*] Based on maximum-day extra capacity unit cost of $19.0561/year/thou. gpd divided by 365 days/year (or $0.0522/thou. gal) applied to the extra capacity factor shown in column 3.

[†] Based on maximum-hour extra capacity unit cost of $17.4545/year/thou. gpd divided by 365 days/year (or $0.0478/thou. gal) applied to the extra capacity factor shown in column 5.

[‡] Total cost per thou. gal is equal to sum of values shown in columns 2, 4, and 6.

Source: Water Rates, American Water Works Association, 1983.

EXHIBIT C-17

Summary of Customer Water Use by Rate Block and Application of Proposed Rates
Test Year

Line No.	Customer Class	(1) Monthly Usage Block *thou. gal*	(2) Percent of Use %	(3) Annual Water Use *thou. gal*	(4) Proposed Rates *$/thou. gal*	(5) Revenue Under Proposed Rates $	(6) Allocated Cost of Service $	(7) Revenue as a Percent of Cost of Service %
	Inside-city							
1	Residential	Service Charge				755,200		
2		First 15	94.0	872,300	0.52	453,600		
3		Next 1485	6.0	55,700	0.46	25,600		
4		Over 1500			0.36			
5		Total	100.0	928,000		1,234,000	1,234,600	99.9
6	Commercial	Service Charge				67,400		
7		First 15	15.0	88,500	0.52	46,000		
8		Next 1485	79.0	466,100	0.46	214,400		
9		Over 1500	6.0	35,400	0.36	12,700		
10		Total	100.0	590,000		340,500	337,600	100.9
11	Industrial	Service Charge				3,700		
12		First 15	0.2	2,300	0.52	1,000		
13		Next 1485	13.8	158,600	0.46	73,200		
14		Over 1500	86.0	988,100	0.36	355,700		
15		Total	100.0	1,149,000		433,600	431,400	100.5
16	*Public Fire-Protection Service Annual Charge*			1155 hydrants	$153/hydrant	176,700	175,900	100.5
	Outside-city							
17	Wholesale	Service Charge				500		
18		All Usage	100.0	210,000	0.57	119,700		
		Total				120,200	120,500	99.8
19	Total					2,305,400	2,300,000	100.2

Source: Water Rates, American Water Works Association, 1983.

Neither the Ontario government nor the average Ontario water utility have established a commitment to water conservation in ensuring that users of these systems pay the real costs of service on a fair and equitable basis.

C.6 RATE SETTING IN OTHER JURISDICTIONS

Until the end of the nineteenth century most residential service supplied by private and public utilities in the Western World was based on flat rate pricing. Even today, the United Kingdom (may be metered by 1995), New Zealand except Auckland, most of Australia, and Norway use flat rate domestic charges.

Tate's study for Canada (C-9) revealed 275 out of 591 utilities used some form of flat rate charges (99 out of 233 in Ontario). A range of public water schedules for three example countries are set out in Exhibit C-18.

In all of this, the overwhelming impediment to adequate water pricing is the lack of universal metering. At best there are less than 50 percent of municipal water services metered in Canada (40 percent in Ontario), and in some countries, none.

Probably the best demonstration of the political attitudes to water metering can be demonstrated by two major U.S. cities. Having suffered from periodic drought conditions in recent decades as well as strong opposition to new water sources, New York City embarked in 1988 on a ten year program to meter all consumers at a cost of $290 million (U.S.) with an estimated saving of 30% in average water demand. Yet the City of Chicago recently advised Illinois State Water officials that the city had no intention of facing the costs of residential metering and indicated that such metering would reduce revenues due to customer conservation.

EXHIBIT C-18

PUBLIC WATER SUPPLY RATE SCHEDULES IN THREE COUNTRIES

	USA (All sectors, 1982)	Belgium (All sectors, 1983?)	Canada (Residential sector, 1983)
Fixed charge	-	5	62
Uniform volume charge	2		-
Fixed charge + volume charge	7	19	-
Minimum charge + volume charge	26		-
Fixed charge + decreasing block	4		
Minimum charge + decreasing block	56	69	34
Fixed charge + increasing block	3		
Minimum charge + increasing block	1	7	4
Fixed charge + seasonal rate	1	-	-
	100 %	100 %	100 %
No. of utilities in sample	(90)	(80)	(205)

Source: Pricing of Water Services, OECD, 1987.

C.7 SEWER RATES

Sewer rates are essentially designed on the same basis as water rates. The expense and difficulty of separately measuring waste volumes for residential users of sewage works is so great that charges for these services are usually based on the structure of rates for the applicable water utility. Usually additions to the fixed and variable aspects of the water rate schedules are made to cover the revenues required in providing waste water service. The assumption is made that water consumed on a property will equal waste water discharged in volume and therefore a waste water service surcharge can be justified.

Unfortunately waste strengths vary considerably as do relative volumes of water supplied and wastewater created, so the equality can be badly flawed.

As in the case of water rate schedules many flat rate schedules for waste water service exist including the levy against rateable property which is most popular in Ontario.

In the United States, the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500) have required municipalities to adopt a user charge system to recover Operation and Maintenance Costs as a condition for obtaining federal construction grant funds. The Municipal Wastewater Treatment Construction Grants Amendments of 1981 (PL 97-117) require that grant assistance will not be awarded until an approved user charge system that will produce adequate revenues required for operation, maintenance and replacement of the system is in force. There also must be an adequate financial management system that will generate sufficient revenues from the system for operation, maintenance and replacement of the waste water control system.

Much of this has spilled over into the practice of Ontario waste water control utilities. Indeed MISA officials are requiring municipalities operating sewage works to consider user pay schemes at least in respect of the sewer use control program using:

1. Ad Valorem Tax Increases for all users - This approach would set rates for sewer use on property values which has no relation to water use or waste creation.

2. Surcharge to all users - distribute the charge to all sewer users based on a flat rate system.

3. Surcharge to Significant Industrial Dischargers - levy charges against those industries being regulated by the sewer use control program only.

4. Proportional charges to all users - levy a surcharge on all water users for their use of the sewer system.

5. Proportional charges to Significant and Controlled Industries - levy a surcharge on the water charges of industries being regulated.

The eventual scheme made uniform over all systems within the province avoids province-wide inconsistency in charging for sewer regulation and waste water control services.

A final variation in sewage works charges not applicable to a waterworks rate structure, is the matter of a surcharge for extra strength wastes based on conventional parameters discharged by a consumer to the sewerage system. Under this system, the customer whose discharge requires a larger expenditure of power, chemicals, and other services for the necessary level of treatment and sludge processing would be assessed a larger share of waste water control costs. MISA officials have raised the issue of surcharges for extra strength wastes in Ontario based on conventional pollutants. The advantages and disadvantages of such a system of rates will be reviewed during the sewer regulation development.

C.8 REALISTIC RATE SETTING ALTERNATIVES

Attempting to design an adequate rate schedule without the universal metering of water is a virtual impossibility. To attempt to arrive at full cost pricing of water and wastewater services, and to properly enforce a user pay policy where the user will conserve rather than waste, requires that water used by all customers be metered.

Assuming therefore metering as an enforced utility requirement, there are in vogue several rate schedule systems that have merit as follows.

1. Service Charge and Declining Block Rate

This system fairly assesses costs according to use and type of use, but does not promote conservation whether using the base-extra capacity or commodity-demand method. Indeed it encourages wasteful uses and excess wastewater flows.

2. Service Charge plus Uniform Rate

Here there is no discounted rate for increased volume of use. This schedule has the advantage that there is cost reduction for increased use and therefore it provides for conservation. The service rate and uniform charge can be varied between customer classes.

3. Service charge plus Inverted Block Rate

Here is the counterpart to declining block rates. Its use is relatively recent and it stems from the need to conserve on water and reduce waste water. Its design cannot be patterned after traditional base-extra capacity and commodity-demand systems.

4. Marginal Incremental Water Rates

This rate is based on the economic theory that the charge for all water sold should reflect the cost of the most recent increment in system capacity even though the average cost would be less. The contention is that by such pricing customers are made aware of the true price of water and therefore the opportunity to decide economically as to his extent of its use.

It has strong conservation benefits but it would result in collecting revenues considerably in excess of current needs.

5. Special Rates

Availability Charges represent recovery of capital-related costs incurred by a utility when constructing for future customers. When used the charge is normally part of a utility's general water-rate structure. It is levied only between the time service is first made available to a potential customer and the time when that customer initiates use. It provides for equity and fairness but has little conservation implication.

Demand Contract Charges might be set when a large customer needs a firm water supply that would represent a significant portion of the system's capacity. The utility assures the customer of firm service but the customer guarantees to pay all fixed charges, despite volume use, up to the firm limit over a specific period of years. It has fairness and equity built in as well as protecting against water waste.

Fire Protection Charges relate to protecting the value of property and therefore should not be included as a charge against the water user but should be collected as a levy against rateable property.

Capital Contributions Charges are established when new growth requires financial investment that will not directly or totally benefit existing customers. The charges are designed to permit the new customers to "buy-in" to the system by picking up the capital charges relating to their requirements. Fairness and equity is thus reasonably maintained and following the one time "buy-in" all customers continue to pay on the normal rate schedule.

In new land development, developers normally install and pay for local water and sewer services at no cost to the utility. In actual fact these costs are rolled into house prices. Additionally, developers frequently are required to make a capital contribution to the proportion of the cost of the spines of both systems that their new capacity demands. Charges are levied on a cost per acre developed, per lot developed, etc. To be fair and equitable however they must be technically and financially justified.

In cases of redevelopment where new construction will increase the demands on existing lateral systems as well as the major trunk and treatment systems, a charge is developed to ensure that these new demands will not bring increased costs to existing consumers. The charge must be technically and financially justified and usually is established as a charge per square metre of new floor area created after deducting for the floor area replaced by the redevelopment.

Local Improvement Charges are charges created in Ontario under the Local Improvement Act where lateral mains or sewers and services are extended to directly supply new customers in previously unserviced areas. This is a traditional form of assessing the cost of local works and is charged as a direct frontage levy against property over a period of 15 to 25 years. The works can be installed at the initiative of a municipality subject to public hearings, the petition of local residents, or on the order of the Minister of Health.

Seasonal or Peak Load Charges may be established to charge customers for excess water use during peak periods of demand. To consider their use, the utility must have all customers metered and then apply an excess use charge to water used over the average demand during peak demand periods. Excess use charges are characterized by having one base schedule of charges for the low demand period of the year (cold weather months) and an additional charge for use in excess of the base amount during a peak water using period (warm weather). The volume of excess use is delineated on a per customer basis and charges are developed on either a base-extra capacity or commodity-demand basis. These charges reflect a real opportunity to introduce conservation incentives as well as maintain fairness and equity in charges among customers. The charges can be readily accommodated in a commodity-demand rate schedule that provides for a customer service charge, a commodity charge based on total volume of water used, and a demand charge based on the volume of excess use.

C.9 CONCLUSIONS

Much has been written by the water supply and water pollution control industry associations on the recommended manner of charging for water on a fair and equitable basis as well as conserving on its use. Many individual authorities have studied the issue at length and published their findings in a myriad of documents.

The fact is that the best technically, financially, and economically justified systems have been frequently too complex for political acceptance and customer support.

The needs for funds and the rate schedules required to generate them from the customers must be simple and sold on the basis of sustainable development practiced

by the utility and supported on a full cost pricing basis by universally metered customers. To achieve the goal requires a well founded public understanding and acceptance program to educate the politician and the consumer alike to the real importance of the issue and the design of a rate system to support it.

APPENDIX C - REFERENCES

C-1 Environment Canada - Report of Inquiry on Federal Water Policy - "Currents of Change" - Ottawa, September 1985.

C-2 American Society of Civil Engineers and American Bar Association - Fundamental Considerations in Rates and Rate Structures for Water and Sewage Works - Ohio State Law Journal - Spring 1951 - Vol. 12

C-3 Submission of the Canadian Chamber of Commerce to the Federal Government of Canada on "The Commercialization of Crown Companies" - May 1985.

C-4 James Goldstein - "Full Cost Water Pricing" - Journal, American Water Works Association - February 1986.

C-5 American Water Works Association - "Water Rates" Manual M-1, Third Edition - 1983.

C-6 American Water Works Association - Water Rates and Related Changes - Manual 1926 to 1986.

C-7 Organization for Economic Co-operation and Development (OECD) - P. Herrington - "Pricing of Water Services" - 1987.

C-8 George A. Raftels - "Water and Wastewater Finance and Pricing" - Lewis Publishers, Chelsea, Michigan - 1989.

C-9 D. M. Tate - "Water Demand Management in Canada" - Environment Canada - 1988.

APPENDIX C - EXHIBITS

C-1 Municipal Water Supply by User Class - Environment Canada, National Inventory, 1981.

C-2 Allocation of Plant Value - Base-Extra Capacity Method - Test Year - **Ref. 5.**

C-3 Allocation of Depreciation Expense - Base-Extra Capacity Method - Test Year - **Ref. 5.**

C-4 Allocation of Operation and Maintenance Expense - Base-Extra Capacity Method - Test Year - **Ref. 5.**

C-5 Allocation of Plant Value - Commodity-Demand Method - Test Year - **Ref. 5.**

C-6 Allocation of Depreciation Expense Commodity-Demand Method - Test Year - **Ref. 5.**

C-7 Allocation of Operating and Maintenance Expense - Commodity-Demand Method - Test Year - **Ref. 5.**

C-8 Units of Service - Base-Extra Capacity Method - Test Year - **Ref. 5.**

C-9 Units Costs of Service - Base-Extra Capacity Method - Test Year - **Ref. 5.**

C-10 Units of Service - Commodity-Demand Method - Test Year - **Ref. 5.**

C-11 Unit Costs of Service - Commodity-Demand Method - Test Year - **Ref. 5.**

C-12 Cost Distribution to Customer Classes - Base-Extra Capacity Method - Test Year - **Ref. 5.**

C-13 Cost Distribution to Customer Classes - Commodity-Demand Method - Test Year - **Ref. 5.**

C-14 Revenue Requirements under Cash Needs and Utility Approaches - **Ref. 8,** p.123.

C-15 Design of Monthly Service Charges - Test Year - **Ref.** 5.

C-16 Deprivation of Typical Cost Per Thousand Gallons by Water-Use Blocks - Test Year - **Ref. 5.**

C-17 Summary of Customer Water Use by Rate Block and Application Proposed Rates - Test Year - **Ref. 5.**

C-18 Public Water Supply Rates Schedules in Three Countries - **Ref. 7,** p.40.

APPENDIX D

DEMAND MANAGEMENT USING METERING AND PRICING

APPENDIX D

DEMAND MANAGEMENT USING METERING AND PRICING

D.1 GENERAL

Water management in Ontario has traditionally focused on managing the supply. As long as water was plentiful relative to demands, supply management appeared to be the logical approach. So municipal water and waste water systems were under continual pressure to expand capacity to meet the thirst of a healthy growth in population and industry.

Today, however, the policy of simply increasing capacity to meet growing demands has become unacceptable. Pollution threats, energy shortages, and resource mismanagement clearly demonstrate the need for a demand management approach with respect to all our natural resources.

Supplying increased capacity in water and sewage infrastructure, simply to provide for unconserved flows not only requires excessive capital spending but such wasteful flows place undue demands on the raw water source and create increased volumes of waste water that must be treated.

One of the non-structural options to conserve on water use is to introduce a suitable price for its use based on the demand volume. The combination of an effective water pricing policy with universal customer metering can do much to control water demand as demonstrated in the following commentary.

D.2 PRICE ELASTICITY

The concept of price elasticity is used generally to express the effectiveness of pricing in reducing water use, but it obviously cannot be applied usefully without metering of the consumer's demand.

Price elasticity is defined as the relative change in commodity use to the relative change in price. To demonstrate, by one study the price elasticity of inside water use was estimated to be -0.26 and outside the home use, -0.40 (D-1). This can be interpreted broadly that a 10 percent increase in price would result in about a 2.6 percent decrease in inside water use and about a 4 percent reduction in outside use.

Now in practicable experience, these values would vary widely depending on the class of consumer. A residential consumer having a large water demand and a higher personal income would not respond to price increase in the same fashion as a customer of lower income and reduced real estate. The higher the personal income, the less response can be anticipated. On the other hand, the use of a seasonal water rates schedule setting a 25 to 40 percent increase in prices for water used in peak warm weather periods can create more significant demand reductions. The OECD in reporting on water pricing (D-2), (see Exhibit D-1), made it clear that price elasticities can vary from zero to a high of -0.70 and are usually significantly higher than zero.

However, where previous average or off peak season uses had suggested price elasticities of -0.4 as appropriate, it now seems more realistic to quote price elasticities for year round use in the -0.05 to -0.30 range. Actually, the experience of the East Bay Municipal Utility District (EBMUD) in California suggests (D-3) that it is doubtful that normal annual rate increases (to cover inflation, etc.) of 4 to 5 percent will yield a measurable impact on water demand. However, significant elasticities in the range of -0.1 to -0.25 were identified for the summer months when seasonal surcharges of 25 to 50 percent on surplus demand were instituted.

EBMUD has discovered a very strong correlation in forecasting water demand based on historical use under varying weather conditions and price elasticity variations. This has permitted the utility to develop sophisticated software to disclose responses to demand forecasts under a number of price and weather variables. Individual utilities can develop their own data showing how their customers have and will react to price change using similar software.

The foregoing remarks relate to price impact on primarily residential consumers. Commercial users normally consider water as a relatively small part of their overall costs of operation. As a result, Hanke as one authority (D-1) considers commercial water demand relatively inelastic, that is, demand will not reduce significantly in the face of price increases within a reasonable range.

EXHIBIT D-1

PRICE ELASTICITIES FOR URBAN PUBLIC WATER SUPPLY

Country	Location	Type of Study	Estimated Price Elasticity	Reference
Australia	971 households in 20 groups in Perth	readings over 1976-82; pooled x-section and time series	overall: -0.11	Metropolitan Water Authority, 1985
Australia	315 households in Perth	x-section (hypothetical valuation technique)	in-house: -0.04 ex-house: -0.31 overall: 0.18	Thomas, Syme and Gosselink, 1983
Australia	metered	x-section(?)	winter: -0.36	Gallagher and Robinson, 1977
Australia	137 households in Toowoomba Queensland	1972-3 to 1976-7 pooled cross-section and time series	short-term: -0.26 long-term: -0.75	Gallagher et al., 1981
Canada	Urban demand eastern Canada	x-section 1960s	winter: -0.75 summer: -1.07	Grima, 1972
Canada	Municipal demand Victoria, B.C.	time series 1954-70	winter: -0.58 summer: zero mid-peak: -0.25 year-round: -0.40	Sewell and Roueche, 1974
England and Wales	411 firms in Severn-Trent	water-saving investment in 1972-78	-0.3	Thackray and Archibald, 1981
England and Wales	Industrial (metered) consumption England & Wales	time series 1962-80	year-round: -0.3	Herrington, 1982
Finland	Municipal demand Helsinki	time series 1970-78	year-round: -0.11	Laukkanen, 1981
Netherlands	Industrial demand, Rotterdam	time series 1960s and 1970s	"no price elasticity demonstrated"	Rotterdam Water Authority, 1976
Sweden	69 domestic residences in Malmo	14 readings each over 1971-78; pooled cross-section and time series	year-round: -0.15	Hanke & de Maré, 1982
United States	2159 households in Tucson, Arizona (water use per household)	42 readings each over 42 months, July 1976-Dec. 1979; pooled cross-section and time series	year-round: -0.256	Martin, Ingram, Laney & Griffin, 1983
United States	Domestic use in Tucson, Arizona	time series Jan. 1974-Sept. 1977	year-round (1): (log model) -0.27 (linear) -0.45/-0.61	Billings and Agthe, 1980
United States	Residential use in 21 study areas, eastern and western United States	cross-section early 1960s	winter: -0.06 (2) summer: -0.57 (2) (east) summer: -0.43 (2) (west)	Howe, 1982

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1. Price included volumetric price of sewer use and the whole tariff schedule (increasing block was assumed to change in the same proportion as 'marginal rate' changes).

2. Changes in marginal price (= marginal block rate) only, although intramarginal rate structure allowed for in demand function. These elasticities represent significant reductions on those estimated from the same data fifteen years earlier (when the intramarginal rate structure was not allowed for): -0.23, -0.86 and -0.52, respectively (see Howe and Linaweaver, 1967, and Howe, 1982).

Source: Pricing of Water Services, OECD, 1987.

However, the price elasticity for water used in industry can be as high as -0.7 for some industries having high demands. Industrial re-use of water has made a notable advance in water conservation during the seventies and eighties as industry realized the considerable cost of treating waste water flows created by water wastage in the process flow. Some of this emphasis can also be attributed to the need to conserve on energy during this same period.

There is a minimum however to which we can reduce the use of water under current high living standards, public health requirements and pollution control needs. It may well be that the normal correlations between price increase and water demand reduction, as demonstrated by elasticity experiences to date, will change in the future.

With the costs of system growth (sometimes in the face of increasingly scarce supplies), the frightening backlog of deferred system maintenance and rehabilitation, the cost of wastewater treatment improvement including the control of combined sewer overflows, and the possible requirement for drinking water quality improvements, we have finally created a condition where the need for increased utility revenues is not only tremendous but critical.

Our current basis of pricing is flawed and the pricing information is imperfect (D-5). The historical abundance of water has shaped our institutions and attitudes so as to cause flawed pricing practices and distorted consumer perceptions of value.

The customer perception that water is inexpensive has evolved into the notion that water should be inexpensive. Now that we face a need to conserve on its use and double or triple its price, the customer's willingness to pay can evaporate overnight unless we undertake a positive public education and acceptance program.

So it is difficult to determine the net effect of price increase, of the magnitude described, on water demand. It may create price elasticities of a more significant value (possibly -0.3 to -0.4) but the rules of economics will give way to the need to educate the consumer to the real value of a resource which is threatened by his misuse to the point of endangering all of us.

D.3 METERING

The discussion of the previous subsection makes obvious the need for universal metering of water consumers for both water supply conservation and wastewater control. Without metering there is no hope to effect demand management of water and demand-related pricing. It is a legitimate first step in establishing an effective water pricing and conservation program.

At the present time there is a wide variation in metering practices among Ontario, Canadian, and foreign water utilities. Exhibit D-2 sets out the extent of domestic metering in many OECD countries. Normally most utilities meter their major customers such as industries, larger commercial buildings, car washes, etc. but as Tate points out (D-6) only about 50 percent of all connections to municipal water utilities in Canada are metered, an overwhelming impediment to pricing based on water use. Tate estimates that based on today's figures about 3 million meters would have to be installed at a cost of $ 250 per meter so that the total national outlay of $ 750 million would be required on a capital basis or here in Ontario about $ 250 million. These figures are small compared to cost for system rehabilitation and improvement that are listed in other parts of this report. Annual spending for system rehabilitation in Ontario should increase from $ 80 million to $ 250 million as an example.

When coupled with significant price restructuring and a move to full cost pricing, metering can substantially reduce water use and improve water management (control unaccounted for water as example). New York City has indicated that it expects to reduce water demand by 30 percent over the next 10 years by moving to universal metering at a cost of $ 340 million (Can.). Initially significant reduction of this order has been the experience of many utilities such as Ottawa-Carleton, Kingston and Kitchener when instituting metering alone, but over the long term customer response lessened so that eventual savings were in the order of 15 to 20 percent. However with substantial price increases and metering the combined impact can be considerably higher - 30 to 40 percent. This is well demonstrated in Exhibit D-3 where studies undertaken on behalf of the City of Calgary (D-7) revealed that the average day water consumption of six Canadian cities with metered water supply systems was 110 gallons per capita, while in five cities using predominantly flat rate systems the consumption was 179 gallons per capita per day - the first group using 62 percent of the flat rate group. Rates for the maximum hour were virtually twice as much in the unmetered systems.

EXHIBIT D-2

DOMESTIC METERING IN OECD MEMBER STATES*

Country	Extent of Household Metering	Comments
Australia	All metered but large 'allowances' mean that only about x % of households pay for any water by volume	
Canada	60 % of utilities surveyed in 1983 used a flat-rate tariff	
Denmark	In towns virtually all metered; in rural areas usually unmetered.	
Federal Republic of Germany	Only 30 %-40 % of households directly metered (very few in individual apartments)	
Finland	Non-apartment households metered? Approx. position in apartments?	In apartments, separate water/ wastewater charge usually based on no. of persons living in flat.
France	All separate dwellings metered; individual apartments: 50 % metered for cold water and 85 % for hot (1972 figures)	meters read twice a year
Japan	All households metered (including those in apartments)?	Meters in households read every one or two months.
Netherlands	75 % separately metered 6 % collectively metered 19 % unmetered	Local water works company discretion exists 17 out of 100 cos. reported 100 % metering (in 1982, 32 % of Dutch dwellings were flats. Thus, 81 % of flats had separate meters?)
Norway	About 10 %?	Local discretion; 100 % metering of new dwellings in some areas. Some 'new' metering of old properties.
Switzerland	90 % of all buildings supplied by public water supply have meters	
U.K. (England & Wales only)	0.36 % of households have meters	At discretion of individual household, except compulsory metering of all owners of automatic lawn sprinklers in South-West WA (April 1984) and Welsh WA (April 1985)
United States	96 % of connections metered in 132 large utilities serving 70 m. people in total; approx. 25 %/30 % of dwellings collectively metered and 5 % unmetered	Calculated from 1981 A.W.W.A. survey and 1982 Census. Usual billing period: every 2 or 3 months.

Sources: Country submissions.

* Individual households assumed to pay (at least in part) by volume if metered, unless indication to the contrary.

Hot water provided in apartments under district heating schemes is normally metered.

Source: Pricing of Water Services, OECD, 1987.

EXHIBIT D-3

AVERAGE AND MAXIMUM DEMANDS FOR SELECTED FLAT RATE AND METERED MUNICIPALITIES

Municipality	Year	Serviced Population	Average Day		Maximum Day		Maximum Hour	
			(mgd)	(gpcd)	(mgd)	(gpcd)	(mgd)	(gpcd)
Metered Systems:								
Chatham, Ont	1977	40,452	4.54	112	9.11	225	11.80	292
London, Ont	1978	253,726	26.3	104	44.8	117	67.0	264
Ottawa, Ont	1978	470,500	57.3	122	90.0	192	153.5	326
Winnipeg, Man*	1978	590,000	55.9	95	72.6	123	105.6	179
South Peel, Ont	1978	397,304	42.4	107	68.4	172	110.1	277
Edmonton, Alta	1977	562,000	59.8	106	102.5	182	162.0	288
		Average Metered:		110		190		245
Flat Rate Systems:								
Calgary, Alta	5-yr avg	472,992	79.3	168	149.2	315	235.9	498
Niagara Falls, Ont	1978	67,600	10.1	149	18.6	275	33.9	501
Vancouver, BC	1978	416,612	54.2	152	-	335	-	520
Peterborough, Ont	1978	59,000	10.6	180	19.4	329	28.7	486
Hamilton, Ont	1969	297,000	69.0	232	102.6	345	144.4	486
		Average Flat Rate:		176		320		498

* Excluded from analysis - data appears inconsistent.

Source: The City of Calgary Water Conservation Study, Acres Consulting Services Ltd, February 1980.

The reduced consumption related to metering alone, and metering and full cost pricing combined can be best justified by a detailed cost-benefit analysis. The analysis identifies capital and operating dollars saved in treating and pumping water, treating waste water, reducing unaccounted for water which can be finally accomplished in a fully metered water system, reduction of demand or supply sources, reduction of pollution of receiving waters as well as offsetting costs such as meter supply and installation, meter reading and repair, and customer billing and service.

The Canadian Water and Wastewater Association undertook a metering study (8) with the sponsorship of Environment Canada in 1988-89 as a part of which it constructed a software program to model the benefits and costs of universal metering in a water and waste water utility. This model "Water Met" identifies in a comprehensive fashion the various items to be quantified in arriving at the ultimate benefit versus cost relationship. Hetherington (D-2) demonstrates two formulae to effect: (1) an economic appraisal and (2) a financial assessment of the benefits of metering. Examples fed into both of these latter programs failed to justify metering on either grounds. Most Canadian studies to date have revealed a positive benefit in favour of universal metering, with the financial savings approximately slightly exceeding the cost of metering. The real benefit lies in the fact that full cost pricing for water conservation cannot be achieved without meters.

Indeed the advantages and disadvantages of water metering depend to some extent on perspective. For example, water meter manufacturers see many advantages and few disadvantages while many utility managers shudder over the arrangements for meter reading and maintenance.

Public acceptance of water metering is a critical issue in the decision making. Two municipal plebiscites on compulsory water meters, conducted in Calgary in 1954 and 1966, indicated domestic consumers were against meters by a ratio of 5:1.

Consumer surveys conducted on public reaction after the water conservation study of 1980 indicated as follows.

	1985	1983	1982
Agree	49%	41%	52%
Disagree	38%	41%	36%
No opinion	13%	17%	12%

with younger residents more likely to agree than older and renters more likely to be affirmative than owners.

Encouraged by these surveys, the City Engineering Department undertook a further study of water conservation and the benefits of metering in 1988, and after a public education and promotion campaign conducted a third plebiscite in October 1989. The results were against metering on a ratio of 2.5:1, much reduced from previous plebiscites but still very negative.

In summary, the most significant advantage of metering, especially if accompanied by a commitment to full cost pricing on a user-pay basis for water supply and waste water management, is conservation of the source of supply and the condition of the receiving water through reduction in per capita use. In the sense of sustainable development this is the critical issue. Complimentary to that of course, is that the utility develops sufficient revenues to be self-financing and therefore able to maintain funds in reserve for rehabilitation and expansion.

Another powerful advantage is the ability to fully account through water and waste water audits of the consumption of water and thereby reduce wastage from leakage and unauthorized usage. This can have considerable effects on the requirements for system capacity in supply, treatment and transmission of water in the collection and treatment of wastewater.

The next most impressive advantage is one of fairness. Customer's use and cost become discretionary and they reflect the democratic process. Also the water rate schedule can be designed to reflect the relative cost of use among customer types including peak charging.

Another significant advantage is that demand forecasting, system planning, design and financing can be established on a sound data base from which to better manage and operate the utility.

D.4 CONCLUSION

The decision to adequately price water on a universally metered basis represents an essential aspect of achieving sustainable development in the municipal utility field, and of adequately linking the economic benefits achieved with environmental improvements inherent in the action. Combined they represent the single most positive action that can be undertaken in demand management, and resource and system conservation.

APPENDIX D - REFERENCES

D-1 Hanke, S. H. - Demand for Water Under Dynamic Conditions - Journal, Water Resources, 6 (5) - October 1970.

D-2 Organization for Economic Co-operation and Development - Herrington, P. - "Pricing of Water Services" - 1987.

D-3 Weber, J. A. - "Forecasting Demand and Measuring Price Elasticity" - AWWA Journal - May 1989.

D-4 MacEwen, P. K. - "Municipal and Industrial Water Rates" - AWWA Journal - October 1977.

D-5 Cromwell, J. E. - "Higher Water Rates and Consumer Willingness to Pay" - Water Engineering and Management - August 1988.

D-6 Tate, D. M. - "Water Demand Management in Canada - A State of the Art Review" - Environment Canada - 1988.

D-7 City of Calgary, Engineering Department - Water Conservation Study by Acres Consulting Services and Gore & Storrie Ltd. - 1980.

D-8 Canadian Water and Waste Water Association - Study on Benefits and Costs of Water Metering - 1989.

APPENDIX D - EXHIBITS

D-1 Price Elasticities for Urban Public Water Supply - **Ref. 2,** p.51.

D-2 Domestic Metering in OECD Member States - **Ref. 2,** p.105.

D-3 Comparison of Average and Maximum Water Demand - Flat Rate Versus Metered Municipalities - Gal/Cap/Day - **Ref. 7,** pp. 2-16.

APPENDIX E

MACKAY'S 3 D's

Paralysis by analysis

Drastic action needed to protect Canada's water resources

Donald Mackay, PhD., P.Eng., a professor of chemical engineering at the U of T, criticises federal research cutbacks in this outspoken article. He also criticises "jurisdictional overkill and paralysis by analysis". Dr. Mackay cites Ontario's MISA program as an example of enlightened leadership.

By Dr. Don Mackay

Many challenges currently face those who provide water supply and disposal in Canada today. Perhaps most difficult of all, is the issue of the large number of toxic contaminants which are present in natural waters and are thus inevitably present in drinking water.

Perhaps we can best address this issue by examining four aspects. First, the *identification of the nature and severity of the problem*, second some *jurisdictional and legal aspects*, then our *present scientific and engineering knowledge of causes and effects*, and finally whether or not there is the *political will* to pay for the remedies.

Identifying the Issue

The news media bombard the public with a continual stream of bad news about toxic chemicals. Much of this news is drawn from the numerous scientific reports which discuss toxic chemicals in water and recommend various remedial actions. Resulting public pressures caused the Federal government to enact the Canadian Environmental Protection Act, and in Ontario the Municipal-Industrial Strategy for Abatement (MISA) program which is now well underway. These programs have not yet reduced contamination levels. It is likely that it will be some years before this occurs, because the initial phases will tend to be data gathering, deciding what should be done and who should pay, rather than actually accomplishing reductions in levels of toxic substances. But the direction is clear. The public is demanding, and will get, a cleaner water environment.

The 3Ds

Ontario has published its list of *Effluent Monitoring Priority Pollutants* which has about 180 chemicals which are believed to be present in Ontario's water, are regarded as being sufficiently toxic to be of concern and so are candidates for monitoring and control. It is likely that even more chemicals will be added to this list as analytical methods improve and new information flows into the system.

Perhaps there are three properties (the three Ds) of chemicals which cause concern. First are chemicals which are *Distributive* or bioconcentrate. For example, PCBs at a concentration of 1 nanogram (10^{-9} g) per litre (ng/L) in water may be able to concentrate in fish and achieve levels of about 1 milligram per kilogram (or ppm) which is a concentration increase by a factor of 1 million. Because of this extreme *Distributive* property, one mouthful of fish can contain the equivalent of a million mouthfuls of water thus providing a vehicle for unusually high human exposure.

Second, are chemicals which are *Directive* or which influence the future growth patterns of organisms. Most chemicals are toxic if taken in sufficient quantities. That toxicity is often caused merely by the disruptive nature of the burden of chemical in the organism. To humans 50 g of alcohol is quite disruptive and 200 g may be fatal. A more insidious problem is caused by chemicals, which in very tiny amounts, are able to affect the organism, not by disrupting it directly, but by directing its growth patterns down undesired pathways. These include carcinogens, mutagens and teratogens.

By analogy, a fly weighing 1 milligram impacting a jumbo jet weighing 500 tonnes has very little effect on the jet - but the same mass of blood clot lodging in precisely the wrong place in the pilot's brain at a critical moment could result in disaster. This is not because of the mass of the clot but because it is able to *direct* a sequence of events which ultimately leads to disaster.

Finally, is the *Durability* or persistence of chemicals. Like humans and other animals, chemicals have a distinct lifetime in the environment which is dictated by their reactivity in the air, water, soil and sediments and especially their susceptibility to biodegradation. Many chemicals such as organic ligneous material of natural origin, PCBs, DDT are very durable. They will survive in the environment for many years. They can build up high concentrations and undertake long environmental journeys permitting them to impact organisms which are some distance from the source. Short-lived chemicals tend to be less of a problem because they are limited to locations close to the discharge point and are unable to build up high concentrations.

Of particular and growing concern are the organochlorine compounds, that is chemicals containing the carbon-chlorine bond. Such compounds are not believed to be produced naturally thus enzymes possess only a limited capability of degrading them. Many of the chemicals on the Ontario list are organochlorines. There is a widely held belief that we should organize a chemical lifestyle to avoid producing, using and discharging such chemicals because of their durability, and in many cases their toxicity.

Chemicals such as PCBs or DDT which possess distributive, directive and durable properties are thus critical environmental contaminants. In large measure the Ontario MISA program is being directed to controlling emissions of these chemicals from sources such as the chemical and pulp and paper industries. As challenging, will be the problem of controlling the emission of such chemicals from homes and light industry into sewers, and thus into natural waters.

The Incomprehensibility of Tinyness

Most environmental regulatory agencies were organized into groups handling chemicals which are classified as air pollutants, agricultural chemicals, water pollutants, etc. It is now clear that this categorization is no longer appropriate. All chemicals have, at least to some extent, the potential to migrate into all media such as air, water, soil and sediment and thus impact humans by inhalation of air, drinking water, eating food, vegetation, meat and fish. It is often not clear which exposure route is dominant. We must also face the reality that it is no longer credible to state that there is *no* dioxin in water. Compounds such as the dioxins are present in all these media, although the concentrations may be well below current analytical detection levels.

We must educate the public to accept the fact that it will never be possible to completely eliminate all toxic chemicals from drinking water. If none are found in drinking water it is merely because the analytical instruments used were not sufficiently expensive.

A fundamental problem in this educational task is that the public and indeed many engineers and scientists, have an inadequate understanding of the concentration units used in reporting levels of toxic chemicals. A concentration of 20 micrograms/litre means little to the average member of the public and probably sounds twice as bad as 10 milligrams/litre despite the fact that it is 500 times lower. We are now dealing with concentrations in the range of nanograms or picograms or femtograms per litre. Even scientists have difficulty remembering what these prefices mean. This problem of *the incomprehensibility of tinyness* raises severe difficulties. When can we ever communicate the concentrations in units that will enlighteh and satisfy a sceptical public?

Intolerance

The public has apparently a strong and growing inherent intolerance, or instinctive dislike, for contaminated air, water and food. How else can one explain the practice of buying bottled water at 40 cents per litre when water of as good quality is available at a cost of 40 cents per thousand litres from the tap? Almost every village has its health food store selling chemical-free, natural organically-grown foods. I have a theory that this distrust of contamination has deep instinctive origins.

Many animals test whether or not to eat material by smell. Their very survival depends on successfully discriminating between poisonous and non-poisonous food. As any wine connosieur knows our senses of taste and smell are closely linked. It may be that to ensure survival we have evolved a strong instinctive desire to select and eat only clean, uncontaminated food. Any food which smells, or looks contaminated produces a strong emotional reaction. Is this the cause of the bizarre and deeply entrenched dislikes of some children for some foods such as spinach or broccoli? When you crack open a rotten egg the response is immediate! We may thus be dealing with an instinctive reaction, not just obstinate intolerance.

This may explain in part why the public feels intensely uncomfortable about drinking water which has been drawn from lakes or rivers which are known to be contaminated, and whose fish exhibit abberations such as high incidences of tumours. Protestations that the water has been treated very thoroughly or that the concentration of compound X is only one part per billion are unlikely to resolve this concern. The concern may be illogical but it is certainly real. Real concern results in real political action. Witness the growing intolerance of smoking!

A simple test of tolerance to contamination is to take a group of people and ask them what level of cleanliness they would expect in a consumer product such as grated cheese. The Health Protection Branch of National Health and Welfare has guidelines which specifies the amount of insect fragments, dead mites, rodent hairs and metal pieces which may be found in samples of grated cheese. Most people would be horrified to learn that there could be any amount of any of these contaminants in purchased grated cheese. Table 1 shows that significant amounts are "acceptable", at least to food inspectors. How many people have died by eating insect fragments, mites or metal pieces in recent years? This is not really a health problem. It is a perception problem.

Table 1: Excerpt from Extraneous Material Guidelines that Relate to the Safety and Cleanliness of Food. (Health Protection Branch, Ottawa) for a 225 g sample of grated cheese.

	n	c	m	M
Insect fragments (not mites)	3	1	4	8
Mites (dead)	3	1	25	34
Rodent hairs	3	1	1	3
Other Mammalian hair (not human)	3	1	1	3
Human hair	3	0	0	0
Rigid metal pieces 0.1 - 1.0 mm	3	1	8	16
Rigid metal pieces 1.0 - 2.0 mm	3	1	1	3
Rigid metal pieces >2.0 mm	3	0	0	0

Explanation:

n	number of samples to be taken
c	maximum number of marginally acceptable samples
m	acceptable amount
M	marginally acceptable amount

We must recognize that the public's attitude to drinking water is linked intimately to the perception of the contamination of the lake from which it is drawn. The perception may be highly emotional, but it

Continued overleaf

Drastic action needed, cont'd.

is certainly real. I suggest that the obvious remedy is to decontaminate rivers and lakes back to the level at which ecosystems thrive, free from unusual incidences of abberations such as tumours. Only when the public can see organisms, preferably the charismatic ones with big brown eyes, thriving and drinking directly from the lake, can there be full assurance that treated drinking water drawn from that lake will be safe and acceptable.

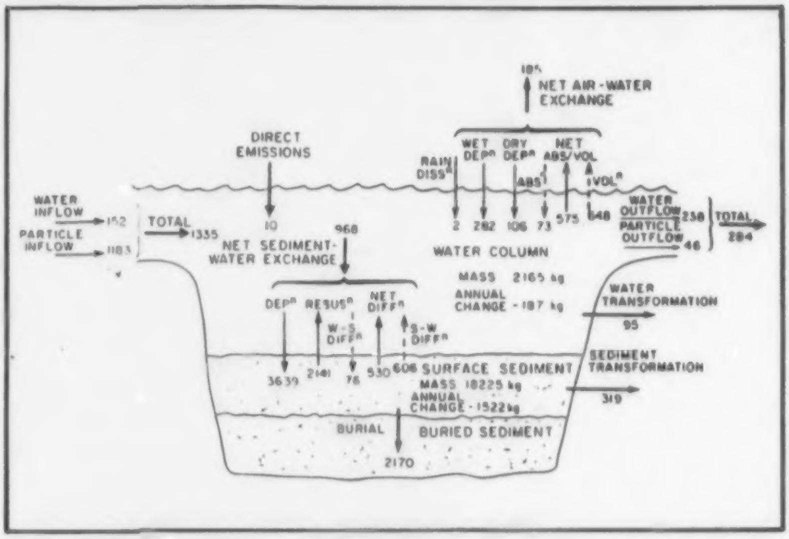

Figure 1: An estimated mass balance diagram for PCBs in Lake Ontario about 1985 in units of kilograms per year.

Jurisdictional Issues

Some environmental issues such as the indoor pollution problem, suffer from lack of jurisdictional attention in that nobody wants to accept responsibility. If we examine some of the jurisdictional actors who are responsible for controlling the contamination in the region of Lake Ontario, we find a very different picture.

There is the Ontario Ministry of Environment and the Federal Department of the Environment which control emissions into the lake. The Department of Fisheries and Oceans worries about its fish, as does the Ontario Ministry of Natural Resources. On the US side are the EPA and the New York State Department of Environmental Conservation. At the International level is the International Joint Commission whose Water Quality Board alone has 31 committees deliberating about the state of the water. National Health and Welfare becomes concerned when the water is drunk, the Department of Transport and the Canadian Coast Guard become active when you float on it; the Department of Public Works is continually rearranging (dredging) the sediments and harbours, as is the US Army Corps of Engineers. Municipalities and industry draw water from the lakes, consultants study it and produce glossy reports. Universities study it and produce generally incomprehensible scientific reports. Environmental nongovernmental organizations (ENGOs) protest about it, the International Association of Great Lakes Research researches it, groups such as this are concerned about it. Harbour and seaway commissions have important interests. No doubt there are many others.

I suggest we are suffering from jurisdictional overkill or *paralysis by analysis.* It is almost impossible for any one of these organizations to take any action without consulting several of the others, forming interdepartmental committees and entering into prolonged negotiations. Communication is often poor, at times reluctant, and occasionally hostile.

We must find a way out of this bureaucratic log jam. The only hope is strong political leadership backed by a vociferous demanding public.

Science, Knowledge, Technology and Understanding

In the last ten years considerable progress has been made in understanding the way in which toxic chemicals enter lakes and migrate between water, sediments and the atmosphere. *Figure I* gives an example of the way in which PCBs are believed to have moved throughout the Lake Ontario environment in the last ten years. It is a tremendous intellectual challenge to understand the processes and deduce amounts subject to each process. Mass Balance diagrams such as Figure I are very difficult to assemble. It requires years of patient work but I am convinced that unless we understand the basic pathways of toxic chemicals we will never be able to regulate or control them properly.

By analogy, the chief executive officer of a large corporation must have an intimate understanding of the cash-flow throughout her organization -- where the money comes from, where it goes, the relative profitability of the various sectors. Only when she has this understanding can she properly direct the organization down more profitable paths. The same principle applies to toxic chemicals. Yet we are trying to manage toxic chemicals without understanding their *cash-flows*. This is an immense problem because there is a multitude of lakes and a multitude of toxic chemicals, and a miniscule amount of effort being devoted to understanding how the two interact.

There is a tremendous enthusiasm within the Ontario scientific community to undertake studies of this type. The only substantial funding for environmental work is now from the Ontario Ministry of the Environment. Yet in its recent awards, it could fund only 11.9% of the proposals submitted. The new proposals funded in the area of water amounted to only $239,000. The Federal government scrapped its Inland Water's Directorate research program and now has no peer reviewed funding program for water research by Canadian universities. Report after report has demonstrated the need for more science, but this falls on deaf ears in Ottawa. Not only are universities starved of research funds, but they are unable to provide educational research opportunities for graduate students wishing to devote their scientific or engineering careers to the solution of water pollution problems.

It is important to emphasize that while we lack understanding of the effects of toxic chemicals, it is now abundantly clear what the immediate actions should be. Too often, lack of scientific knowledge is used as an excuse for inaction, especially in the acid rain issue. Scientists will never admit that they understand a problem sufficiently. There is always more to be discovered. I am told that consultants have rubber stamps which state "Recommendation 1. Further study is needed". It is clear that there is one, and only one, road to decontamination - it is to reduce the loadings or kilograms per day of toxic chemicals into the Great Lakes. Once the chemicals are in the lakes nothing can be done about them. Loading reduction is thus the thrust of the enlightened MISA program.

Recent studies have shown that (i) if loadings are reduced by half then the level of contamination of the Great Lakes will be approximately reduced by half, and (ii) that lakes will respond very rapidly to these loading reductions, often within a year or two. Even for Lake Superior, in which water resides for some 185 years, a reduction in loading will often produce a reduction in water concentration within a couple of years. This is because most chemicals leave the water, not only by outflow, but also by sedimentation, volatilization or reaction. This is very good news and suggests that if we can act in a concerted way to reduce loadings, the Great Lakes may be restored relatively rapidly to a state of cleanliness, just as the Thames recovered very rapidly when Londoners finally decided after centuries of abuse to clean up their river. Remedial actions are thus obvious and need not be delayed for lack of science. Science will play a critical role in deciding when we have reached a state of virtual elimination, i.e. how clean is clean enough?

It is a tragic comment on the state of environmental science that we do not yet have one fully validated mass balance statement for one toxic chemical in one of the Great Lakes.

Political Will and Money

The costs of remediating or decontaminating our water resources are going to be substantial. Maintenance and improvement of urban infrastructure will be expensive. Sewage treatment plants must be upgraded, industrial discharges controlled and comprehensive programs of monitoring and scientific investigation put in place. But all we find is bickering between the various levels of government as to who is going to pay.

It is interesting to contrast this intolerable water situation with that of electricity. In Scarborough Ontario, a city of nearly half a million, in 1986 each residential customer consumed 317 cubic metres of water at 43 cents per cubic metre, costing a total of $136. The amount spent on electricity was $560. - four times greater. One could argue that efforts directed to water resources should be at least a quarter of those devoted to electricity supply. Ontario Hydro is a large, dynamic organization which conducts annually about $80 million worth of research, finances mega projects such as Pickering and Darlington and announces with little fanfare that it will spend $500 million retubing reactors. There is acceptance that the consumer pays the full price for electricity, including provision of new services, upgrading of existing services and research into new technologies. In short, the user pays.

In contrast, the provision of drinking water, maintenance of infrastructure, treatment of wastes and control of contamination of rivers and lakes is badly fragmented, financially starved and research has virtually ceased. Surely average customers would be willing to pay some surcharge on water bills if they could be assured that funds were to be used for the improvement of water resources and for scientific research. Regrettably there is no present mechanism by which this can be done.

Interestingly, any suggestion that electricity be provided to a home but not metered would be met with derision. Yet we persist in supplying many consumers with unmetered water. We have to seek a better mechanism whereby the full costs of maintaining Canada's water resources, providing drinking water and treating sewage are more adequately funded. I hope that part of this will be a complementary program of scientific research.

Again, this needs political leadership. Bitching by municipalities and scientists has become a tiresome burden, which most politicians have learned to accept and ignore.

Some Conclusions

We face a challenging task of stewardship of Canada's water resources. Contamination by toxic chemicals is only one of the issues, but it is a crucial one which we have addressed ineffectively. It is clear that the public has a strong aversion to contaminated water, that we need to clean up the raw water resource, and manage it more carefully. There is clearly a changing public attitude in the direction of increased intolerance of contamination. We must respond.

What then are the impediments to progress? I have suggested three. *First is the problem of jurisdictional overkill,* in which bureaucracies have proliferated to the extent that the taxpayer is no longer served by a lean, responsive organization, but instead is met by frustration, delays and interjurisdictional squabbles. *Second, there is inadequate support of science and engineering,* which are ultimately the only methods by which water can be decontaminated. No amount of reports, lawsuits or committee meetings will result in cleaner water. There must be pragmatic engineering measures and public education to reduce loadings of toxic chemicals. *Third, is the problem of funding.* I am not suggesting that we create a water analog to Ontario Hydro but we must adopt some of the principles which enable Ontario Hydro to be successful, far sighted and responsive. We must seek a mechanism by which the user is able to pay directly for improved service.

So what can be done? We have to break out of this deadlock of bureaucratic squabbling, scientific bitching and poverty-pleading. It can only be done if there is political leadership, and strong public support for that leadership. There are signs of this political leadership in Ontario. The status and impact of the Ontario Ministry of Environment has risen remarkably under the leadership of **Jim Bradley**. We have to send a clear signal to the politicians, such as Mr. Bradley, that the present situation is intolerable; that they must break the present deadlock, and that they will have our full support in efforts to decontaminate our lakes and rivers. Then we might enter into a new and more enlightened era of stewardship of our precious water resources. ***ES&E***